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THE EVOLUTION OF THE DOLLAR MARK

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THERE are few mathematical symbols the origin of which has given rise to more unrestrained speculation and less real scientific study than has our dollar mark, $. About a dozen different theories have been advanced by men of imaginative minds, but not one of these would-be historians permitted himself to be hampered by the underlying facts. These speculators have dwelt with special fondness upon monogrammatic forms, some of which, it must be admitted, maintain considerable antecedent probability. Breathes there an American with soul so dead that he has not been thrilled with patriotic fervor over the "U. S. theory" which ascribes the origin of the $ mark to the superposition of the letters U and S? This view of its origin is the more pleasing because it makes the symbol a strictly American product, without foreign parentage, apparently as much the result of a conscious effort or an act of invention as is the sewing machine or the cotton gin. If such were the case, surely some traces of the time and place of invention should be traceable; there ought to be the usual rival claimants. As a matter of fact no one has ever advanced real evidence in the form of old manuscripts, or connected the symbol with a particular place or individual. Nor have our own somewhat extensive researches yielded evidence in support of the "U S theory." The theory that the $ is an entwined U and S, where U S may mean "United States" or one "Uncle Sam," was quoted in 1876 from an old newspaper clipping in the *Notes and Queries* (London):[1] it is given in cyclopedic references. In the absence of even a trace of evidence from old manuscripts, this explanation must give way to others which, as we shall find, rest upon a strong basis of fact. Possibly these

[1] *Notes and Queries*, 5th S., Vol. 6, London, 1876, p. 386; Vol. 7, p. 98.

statements suffice for some minds. However, knowing that traditional theories are dear to the heart of man, an additional *coup de grace* will not be superfluous. The earliest high official of the United States government to use the dollar mark was Robert Morris, the great financier of the Revolution. Letters in his own handwriting, as well as those penned by his secretary, which we have seen,[2] give the dollar mark with only one downward stroke, thus $. To assume that the symbol is made up of the letters U and S is to assert that Robert Morris and his secretary did not know what the real dollar symbol was; the letter U would demand two downward strokes, connected below. As a matter of fact the "U S theory" has seldom been entertained seriously. Perhaps in derision of this fanciful view, another writer declares "surely the stars and stripes is the obvious explanation."[3]

Minds influenced less by patriotic motives than by ecclesiastical and antiquarian predilections have contributed other explanations of our puzzle. Thus the monogrammatic form of I H S (often erroneously interpreted as *Jesus, Hominum Salvator*) has been suggested.[4] The combination of H S or of I I S, which were abbreviations used by the Romans for a coin called *sestertius,* have been advocated.[5] We should expect the supporters of these hypotheses to endeavor to establish an unbroken line of descent from symbols used at the time of Nero to the symbols used in the time of Washington. But sober genealogical inquiries of this sort were never made or, if made, they brought disaster to the hypotheses.

An interesting hypothesis is advanced by the noted historian, T. F. Medina, of Santiago de Chile. He suggests that perhaps the dollar mark was derived from the stamp of the mint of Potosi in Bolivia. This stamp was the monogrammatic *p* and *s*. Against the validity of this explanation goes the fact that forms of *p* and *s* were used as abbreviations of the "peso" before the time of the establishment of the mint at Potosi.

All the flights of fancy were eclipsed by those who carried the $ back to the "Pillars of Hercules." These pillars were strikingly impressed upon the "pillar dollar," the Spanish silver coin widely used in the Spanish-American colonies of the seventeenth and eighteenth centuries.[6] The "Pillars of Hercules" was the ancient name of the opposite promontories at the Straits of Gibraltar. The Mexican

[2] Letter of 1792 in Harper Memorial Library, University of Chicago; Robt. Morris's Private Letter Book in MSS. Div. of Library of Congress.

[3] *Notes and Queries,* 5th S., Vol. 6, p. 434.

[4] "Standard Dictionary," Art. "Dollar."

[5] M. Townsend, "United States, an Index, etc.," Boston, 1890, p. 420.

[6] *Notes and Queries* (London), 5th S., Vol. 7, 1877, February 24; "New American Cyclopædia," Vol. VI., 1859, Art. "Dollar."

"globe dollar" of Charles III. exhibited between the pillars two globes representing the old and new worlds as subject to Spain. A Spanish banner or a scroll around the pillars of Hercules was claimed to be the origin of the dollar mark.[7] The theory supposes that the mark stamped on the coins was copied into commercial documents. No embarrassments were experienced from the fact that no manuscripts

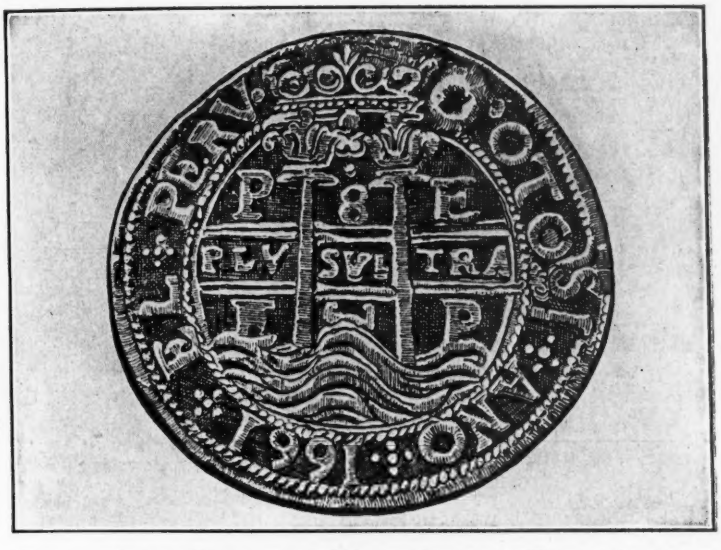


FIG. 1. "PILLAR DOLLAR" OF 1661, showing the "Pillars of Hercules." (From "Century Dictionary," under "Pillar.")

are known which show in writing the imitation of the pillars and scroll. On the contrary, the imaginative historian mounted his Pegasus and pranced into antiquity for revelations still more startling. "The device of the two pillars was stamped upon the coins" of the people who "built Tyre and Carthage"; the Hebrews had "traditions of the pillars of Jachin and Boaz in Solomon's Temple," "still further back in the remote ages we find the earliest known origin of the symbol in connection with the Deity. It was a type of reverence with the first people of the human race who worshipped the sun and the plains of central Asia." The author of this romance facetiously remarks, "from thence the descent of the symbol to our own time is obvious."[8] Strange to say, the ingenious author forgot to state that this connection of the dollar mark with ancient deities accounts for the modern phrase, "the almighty dollar."

Most sober-minded thinkers have been inclined to connect the dollar

[7] M. Townsend, *op. cit.*, p. 420.

[8] "American Historical Record," Vol. III., Philadelphia, pp. 407–8; *Baltimore American*, June 3, 1874.

symbol with the figure 8. We have seen four varieties of this theory. The Spanish dollars were, as a rule, equivalent to eight smaller monetary units, universally know in Spain as "reales" or "reals." The "pillar dollar" shows an 8 between the two pillars. The Spanish dollar was often called a "piece of eight." What guess could be more natural than that the 8 between two pillars suggested the abbreviation |8|, which changed into $? So attractive is this explanation that those who advanced it did not consider it worth while to proceed to the prosaic task of finding out whether such symbols were actually employed in financial accounts by merchants of English and Latin America. Other varieties of theorizing claimed a union of P and 8 ("piece of eight")[9] or of R and 8 ("eight reales")[10] or of |8| (the vertical lines being marks of separation)[11] or of 8/.[12] The "P8 theory" has been given in Webster's "Unabridged Dictionary," not in its first edition, but in the editions since the fourth (1859) or fifth (1864). It is claimed that this widely accepted theory rests on manuscript evidence.[13] One writer who examined old tobacco account books in Virginia reproduces lithographically the fancifully shaped letter *p* used to represent the "piece of eight" in the early years. This part of his article is valuable. But where it comes to the substantiation of the theory that $ is a combination of P and 8, and that the $ had a purely local evolution in the tobacco districts of Virginia, his facts do not bear out his theory. He quotes only one instance of manuscript evidence and the reasoning in connection with that involves evident confusion of thought.[13] To us the "P 8 theory" seemed at one time the most promising working hypothesis, but we were obliged to abandon it, because all evidence pointed in a different direction. We sent inquiries to recent advocates of this theory and to many writers of the present day on early American and Spanish-American history, but failed to get the slightest manuscript evidence in its favor. None of the custodians of manuscript records were able to point out facts in support of this view. We ourselves found some evidence from which a superficial observer might draw wrong inferences. A few manuscripts, particularly one of the year 1696 from Mexico (Oaxaca), now kept in the Ayer Collection of the Newberry Library in Chicago, give abbreviations for the Spanish word "pesos" (the Spanish name for Spanish dollars) which consist of the letter *p* with a mark over it that looks much like a horizontal figure 8. This is shown in Fig. 2. Is it an 8? Paleographic study goes against this conclusion: the mark signifies "os," the last two letters in "pesos." This is evident from

[9] M. Townsend, *op. cit.*, p. 420; *Scribner's Magazine*, Vol. 42, 1907, p. 515.
[10] M. Townsend, *op. cit.*, p. 420.
[11] *Notes and Queries* (London), 5th S., Vol. VII., p. 317.
[12] *Scribner's Magazine*, Vol. 42, 1907, p. 515.
[13] *American Historical Record*, Vol. III., p. 271.

several considerations. The fact that in the same manuscript exactly the same symbol occurs in "vez^{os}," the contraction for "vezinos," or "neighbors," may suffice; an 8 is meaningless here.

We have now described the various hypotheses.[138a]. The reader may have been amused at the widely different conclusions reached. One author gives to the $ "a pedigree as long as chronology itself." Others allow it only about 125 years. One traces it back to the worshippers of the sun in central Asia, another attributes it to a bookkeeper in a Virginia tobacco district. Nearly every one of the dozen theories seemed so simple to its advocate as to be self-evident. A mode of argumentation is revealed much like that of the prospective western farmer planning to solve the problem of irrigation by planting rows of potatoes between rows of onions, "to make the potato-eyes water." He was thoroughly infatuated with the brilliancy of his idea and of course never subjected it to a sober test.

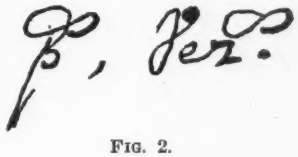


FIG. 2.

In our own researches we have been driven from one working hypothesis to another, until finally we found one which tallied with the facts. Noticing that as a rule the common abbreviations for monetary units used in recent centuries consisted in the initial letter, or that letter and a second one in the word, as M for the German "mark," *fr.* for the French "franc," £ for the English "pound" (libra), we started with the provisional theory that $ came from the letters in the word "dollar." To test the theory we began the examination of colonial manuscripts and made galloping progress in showing that "dollar" was in colonial days actually abbreviated to "Dolls.," "Doll.," "Do.^{s}," "D^{s}," "D." But in endeavoring to show the evolution of D into $ we encountered insuperable difficulties. Thousands of manuscripts were looked over and they absolutely failed to supply the necessary connecting links. We had to throw our theory overboard as a useless burden.

The history of the dollar mark is difficult to trace. The vast majority of old documents give monetary names written out in full. This is the case also in printed books. Of nine Spanish commercial arithmetics of the seventeenth and eighteenth centuries, five gave no abbreviations whatever for the "peso" (also called "piastre," "peso de 8 reales," "piece of eight," "Spanish dollar"). In fact some did not mention the "peso" at all. The reason for the omission of "peso" is that the part of Spain called Castile had monetary units called "reales," "ducados," "maravedises," etc.; the word "peso" was used mainly in Spanish America and those towns of Spain that were in

[138a] Interesting lines of research on the origin of $ were suggested by Professor D. E. Smith in his "Rara Arithmetica," 1908, pp. 470, 471, 491, but we found them barren of results.

closest commercial touch with the Spanish colonies. After the conquest of Mexico and Peru, early in the sixteenth century, Spanish-American mints, established in the various points in the Spanish possessions, poured forth the Spanish dollar in such profusion that it became a universal coin, reaching before the close of the century even the Philippines and China. In the seventeenth century the Spanish "piece of eight" was known in Virginia and much was done to promote the influx of Spanish money into that colony. The United States dollar, adopted in 1785, was avowedly modelled on the average weight of the Spanish dollar coins in circulation. Thomas Jefferson speaks of the dollar as "a known coin, and the most familiar of all to the minds of the people."[14] No United States dollars were actually coined before the year 1794.[15] We proceed to unfold our data and to show the evolution of the dollar mark by stages so easy and natural, that the conclusion is irresistible. There are no important "missing links." To enable the critical reader to verify our data, we give the sources of our evidence. No man's *ipse dixit* is a law in the world of scientific research.

We begin with information extracted from early Spanish printed books, consisting of abbreviations used for "peso" or "pesos."

Ivan Vasquez de Serna,[16]	1620,	*Pes., pes de* 8 *real.*
Francisco Cassany,[17]	1763,	*p,* also *ps.*
Benito Bails,[18]	1790,	*pe,* seldom *p.*
Manuel Antonio Valdes,[19]	1808,	*ps.*

Here we have the printed abbreviations *Pes., ps, pe, p.* More interesting and convincing are the abbreviations found in manuscripts which record commercial transactions. We can give only a small part of the number actually seen. In our selection we are not discriminating against symbols which might suggest a conclusion different from our own. As a matter of fact, such discrimination would be difficult to make, for the reason that all the abbreviations for the "peso," or "piece of eight" or "piastre" that we have examined point unmistakably to only one conclusion. We say this after having seen many hundreds of these symbols in manuscripts, antedating 1800, and written in Mexico, the Philippines, San Felipe de puerto, New Orleans

[14] D. K. Watson, "History of American Coinage," 1899, p. 15.

[15] Gordon, "Congressional Currency," p. 118.

[16] Ivan Vasquez de Serna, "Reducciones de oro," Cadiz, 1620, p. 263 ff. (In the Hispanic Museum, New York City.)

[17] Don Fr. Cassany, "Arithmetica deseada," Madrid, 1763. (In the Library of Congress.)

[18] Don Benito Bails, "Arismetica," Madrid, 1790. (In Library of the American Philosophical Society, Philadelphia.)

[19] Don M. A. Valdes, "Gazetas de Mexico," 1808. (In Newberry Library, Chicago.)

	Place of MS.	Date of MS.		Date of MS.	Place of MS.	
1	Spain	abt. 1500		1598	Mexico City	2
3	Mexico (?)	1601		1633	San Felipe de puerto	4
5	Mexico	1644		1649	Mexico City	6
7	Manila	1672		1696	Mexico	8
9	Mexico	1718		1746	Mexico City	10
11	Chietla (Mexico)	1748		1766	Manila	12
13	Mexico	1768		1769	?	14
15	New Orleans	1778		(1778) 1783	New Orleans	16
17	Mexico City	1781		1786	New Orleans	18
19	On the Mississippi	1787		1787	Mexico City	20
21	Philadelphia	1792		1793	"Nouvelle Madrid" (N. O.)	22
23	"Nouvelle Madrid" (N. O.)	1794		1794	"Nouvelle Madrid" (N. O.)	24
25	"Nouvelle Madrid" (N. O.)	1794		1794	"Nouvelle Madrid" (N. O.)	26
27	New Orleans	1796		1796	Philadelphia (?)	28
29	New Orleans	1796		1799	Louisville (?)	30

FIG. 3. SYMBOLS FOR THE SPANISH DOLLAR OR PESO, traced from MS. letters, contracts and account-books. No. 1. The historian, Dr. Cayetano Coll y Toste, of Porto Rico, says that this was the written symbol "during the time of Christopher Columbus." Nos. 2, 3, 6, 9, 10, 11, 13, 14, 17, 20 are traced from MSS. owned by W. W. Blake, Avenida 16 de Septiembre 13, Mexico City. Nos. 15, 16, 18, 19 are from Draper Coll. in Wis. Hist. Libr., Madison; Nos. 15, 16 in Clark MSS., Vol. 48 J, pp. 37, 38; Nos. 18, 19 in Clark MSS., Vol. 1, pp. 136, 143. Nos. 4, 5, 7, 8, 12 are from the Ayer Coll. Newberry Libr., Chicago. No. 21 from letter of Robt. Morris to the Hon. Jeremiah Wadsworth, Esq., Hartford, Conn., in Harper Mem. Libr., University of Chicago. Nos. 22, 23, 24, 25, 26, 27, 28, 29, 30 are from MSS. in Chicago Hist. Soc. Libr.; No. 22 in Menard Coll., Vol. 64; Nos. 23, 24 in Menard Coll., Vol. 60, p. 187; Nos. 25, 30 in Autogr. Letters, Vol. 61; No. 26 in Menard Coll., Vol. 62; Nos. 27, 29 in Menard Coll., Vol. 63; No. 28 Autogr. Letters, Vol. 71, p. 76.

and the colonies of the United States. It was a remarkable coincidence that all three names by which the Spanish dollar was best known, namely the "peso," "piastre" and "piece of eight," began with the letter *p* and all three were pluralized by the use of the letter *s*. Hence *p* and *ps* admirably answered as abbreviations of any of these names. The symbols in Fig. 3 show that the usual abbreviation was a *ps* or *p*, the letter *p* taking sometimes a florescent form and the *s* in *ps* being as a rule raised above the *p*. The *p* and the *s* are often connected, showing that they were written in these instances by one uninterrupted motion of the pen. As seen in Fig. 3, the same manuscript sometimes shows symbols of widely different shapes. The capital P is a rare occurrence. We have seen it used at the beginning of sentences and a few times written in ledgers at the top of columns of figures. In the sixteenth century the *ps* had above it a mark indicating the omission of part of the word, thus *p̃s*. Sometimes the contraction of the word "pesos" was "pss." or "pos." Not infrequently two or more different abbreviations are found in one and the same manuscript. The body of the text may contain the word written out in full, or contracted to "pss" or "pos," while the margin or the head of a column of figures may exhibit *ps* or simply *p*. These were the abbreviations used by the Spanish-Americans from the sixteenth century down to about 1820 or

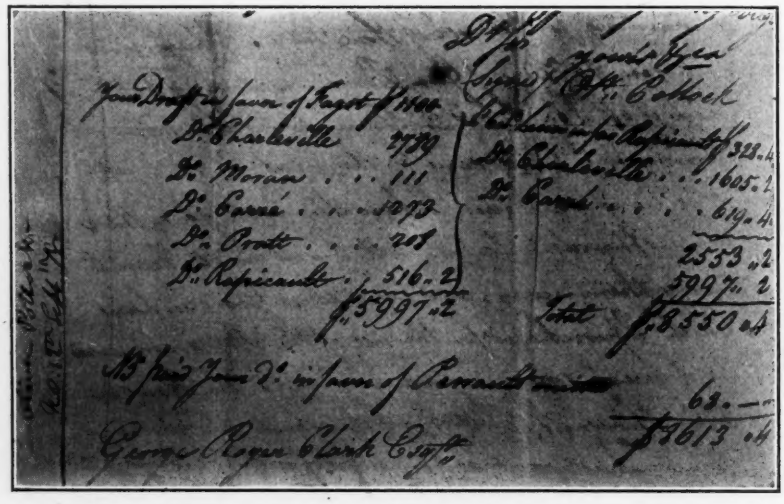


FIG. 4. THE MODERN DOLLAR MARK IN THE MAKING. From copy of letter by Oliver Pollock at New Orleans to George Roger Clark, 1778. (Wis. Hist. Libr., Madison, Draper Coll., Vol. 38 J, p. 37.)

1830. The transition from the *ps* to our modern dollar mark was not made by the Spaniards; it was made by the English-speaking people who came in contact with the Spaniards. At the time when Mexico achieved its independence (1821), the $ was not yet in vogue there.

In a Mexican book of 1834 on statistics[20] both the *ps* and the $ are used. Our $ was introduced into Hawaii by American missionaries, in a translation of Warren Colburn's "Mental Arithmetic" in 1845.[21]

The transition from the florescent p^s to our dollar mark is seen in Fig. 4. Apparently it is a change introduced unconsciously, in the effort to simplify the complicated motion of the pen called for in the florescent p^s. No manuscript on this point is so interesting and convincing as the two contemporaneous copies, made by the same hand, of a letter written in 1778 by Oliver Pollock, then "commercial agent of the United States at New Orleans." Pollock rendered great services to the United States, being to the west what Robert Morris was to the east. Pollock's letter is addressed to George Roger Clark, who was then heading an expedition for the capture of the Illinois country. Both copies of that letter show the $ in the body of the letter, while in the summary of accounts, at the close, the $ and the florescent p^s are both used. These documents show indeed "the modern dollar mark in the making." In the copy from which our photograph is taken, Fig. 4, the 8613 dollars is indicated by the regular $, while in the other copy it is represented by the fancy p^s. Carefully examining the two symbols in our photograph, we see that the p^s is made by one continuous motion of the pen, in this order: Down on the left—up on the right—the loop of the *p*—the *s* above. On the other hand, the $ symbol is made by two motions: One motion down and up for the *p*, the other motion the curve for the *s*, one symbol being superimposed upon the other.

Thus the origin of the dollar mark is simplicity itself. It is an evolution from p^s. When the *p* was made by one long stroke only, as in Fig. 3, Nos. 12, 14, 17, 20, then the $ took the form \$, as used by Robert Morris (Fig. 3, No. 21). Before 1800 the regular mark $ was seldom used. In all our researches we have encountered it in eighteenth-century manuscripts not more than 15 or 20 times. None of these antedates the ones in Oliver Pollock's letter of 1778. But the dollar money was then very familiar. In 1778 theater prices in printed advertisements in Philadelphia ran, "Box, one dollar." An original manuscript document of 1780 gives 34 signatures of subscribers, headed by the signature of George Washington. The subscribers agree to pay the sum annexed to their respective names, "in the promotion of support of a dancing assembly to be held in Morristown this present winter." The sums are given in dollars, but not one of the signers used the $ symbol; they wrote "Dollars," or "Doll," or "D^s."[22]

[20] "Noticias estadisticas del Estado de Chihuahua," par J. A. Escudero, Mexico, 1834.

[21] Copy in the Newberry Library, Chicago.

[22] "American Historical and Literary Curiosities," Philadelphia, 1861, plates 52, 22.

It is interesting to observe that Spanish-Americans placed the *ps* after the numerals, thus 65*ps*, while the English colonists, being accustomed to write £ before the number of pounds, wrote the $ to the left of the numerals, thus $ 65. In the Argentine Republic the $ is to this day written to the right of the numerals, like this 65$.

The earliest known occurrence of the $ *in print* is in an American arithmetic, Chauncey Lee's "American Accomptant," published in 1797 at Lansingburgh. This fact was pointed out in 1899.[23] A recent writer[24] again calls attention to this arithmetic and then, with sweet simplicity of mind, conveys the idea that this publication constitutes the true origin of the dollar mark. By this mental short cut he saved himself the drudgery of a research which, in our case, has extended over several years. After 1800 the symbol began to be used freely, both in print and in writing. On September 29, 1802, William A. Washington wrote a letter on the disposal of part of the bottom land above the Potomac, belonging to the estate of George Washington. In this letter there is mention of "$20," "$30" and "$40" per acre.[25]

In this article it has been established that the $ is the lineal descendent of the Spanish abbreviation p^s for "pesos," that the change from the florescent p^s to $ was made about 1775 by English-Americans who came in business relations with Spanish-Americans, and that the earliest printed $ dates back to the year 1797.

[23] "Report of the Commissioner of Education," 1897–98, p. 811.

[24] *Bankers' Magazine*, Vol. 62, 1908, p. 857.

[25] Letter in Harper Memorial Library, University of Chicago.

PRACTICAL FORESTRY EXPLAINED

By Gen. C. C. ANDREWS

FORMERLY FORESTRY COMMISSIONER OF MINNESOTA

FORESTRY is the science of deriving a sure and fairly good revenue from the production of valuable timber trees on such hilly, rocky or sandy land as is unfit for field crops. The pine takes from the soil only a twelfth part of the mineral matter that is required for field crops. Air and light are its principal food.

The average net income from the German state forests is about three per cent. per annum. The average value of the land containing the forest is about $150 per acre. Much of the land is mountainous.

A normal forest is one from which enough trees can be cut annually for revenue, without impairing the capital. The forest crop has this advantage over field crops that it is not absolutely necessary to cut it at any particular time, but that the cutting can be at a time that will best suit the market. If we had a natural or virgin forest of considerable extent, we should find in it trees of various sizes and ages. (In the Minnesota National Forest, December, 1906, a white pine was cut that was 425 years old, six feet in diameter breast high, and which yielded 6,200 board feet.) If our natural forests were handy to a permanent railroad or the logs could be floated from it by water to a saw-

WHAT FORESTRY SCIENCE DOES. A German forest of spruce planted and managed according to forestry science; trees about eighty and one hundred years old.

A Natural Forest of White Pine in Minnesota.

mill, we could every year cut the more mature trees, leave the younger ones to grow, and in reasonable time bring it into a normal forest. Usually, however, natural forests are remote from established lines of transportation, and the lumberman who handles them must construct temporary logging railroads which are taken up when the timber has all been cut. He has invested his money, expecting to get it back soon with a profit and can not wait for trees to grow. He usually cuts clean as he goes. He can not afford to practise forestry and no reasonable person expects him to do so. It would take too long for nature unaided to renew forest. Natural reforestation has as good a chance in Germany as anywhere because fire there does little damage. But Germany plants over a hundred thousand acres of forest annually.

If we were to start an artificial pine forest it would be by planting seedlings—nursery grown trees—two years old, four feet apart, requiring at that rate 2,722 seedlings per acre. If land we purpose using happens to be part of an abandoned farm or is land from which natural forest was cut twenty or thirty years ago, probably five per cent. of the area is already well stocked by nature with valuable kinds of timber trees. Probably another five per cent. of the area consists of rocks or wet places that can not be planted, so that only ninety per cent. of our area will require to be planted.

Why should trees be planted as close as four feet? To get the ground shaded as soon as possible, to promote moisture and fertility; also to promote height growth. In a crowded forest the shade causes the trees to shed their lower limbs. It is only in this way that long smooth logs, free from knots, are produced. Every one has seen that a tree in the open grows too many branches to make good timber. In a

forest that is crowded when young, a natural thinning occurs as it develops. The weaker trees die out. An average acre of mixed woods in the Black Forest of Germany, which at the age of twenty years contained 3,960 trees, contained at the age of forty years 1,013 trees and at the age of eighty years, 346 trees.

A person intending to start a forest should plant the trees in the spring as soon as the frost is out of the ground. The most economical plan probably will be to buy them of a reliable nurseryman. The forestry departments of some states now furnish seedlings at cost. In 1910 the Superintendent of Forests of the state of New York supplied to private parties at cost 2,733,200 trees, being mostly white pine seedlings two years old. The pine produces a crop of cones every two or three years, and if conditions are very favorable, one might gather the cones, which should be done about the first part of September. By drying them in the sun, the seeds can be shaken out. The seeds should be kept in a cool safe place, and can be sown in the spring in a garden bed in the same way that garden seeds are sown, and the first summer must be protected from the sun by lath screens about two feet above the beds, or by an arbor of boughs ten feet high. In muggy weather, the delicate pine plant is liable to a blight called "damping off" and as a preventative should obtain good air currents. When ready for planting they should be carefully taken up with a spade, not pulled up. The roots must not be exposed to the sun at all. The plants must be car-

NON-AGRICULTURAL LAND, FROM WHICH WHITE-PINE FOREST HAS BEEN REMOVED.

ried to the place of planting in pails of mud. The holes in which they are to be set should be made with a grub hoe or light spade, the soil pulverized, and in planting the roots should be given their natural position, the soil firmed around them, and they should be set two or three inches deeper than the surrounding surface. A young forest should have the sides that are exposed to the prevailing winds more densely planted than elsewhere; wind being one of the forest's worst enemies.

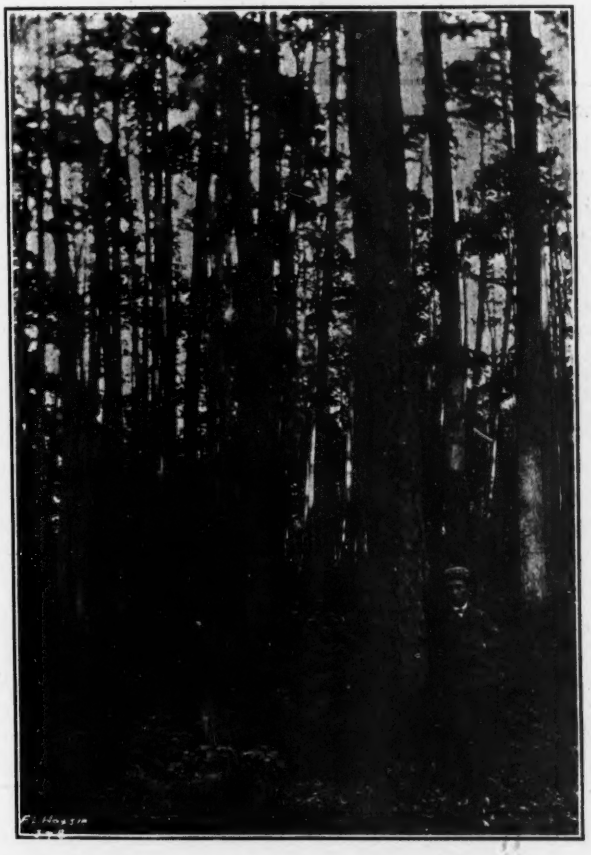
In planting a small tract of even five acres, there may occasionally be a small piece of ground such as the bottom of a ravine, with soil fertile enough to sustain hardwood trees such as the sugar maple, ash, chestnut or oak, and if so, such kind of trees had better be planted, both to improve the appearance of the forest and to attract birds. Two men

NATURAL REPRODUCTION OF WHITE PINE, twenty-five feet high and six to eight inches in diameter, on the Daniel Webster farm at Marshfield, Mass. Grown from seed of pines that were planted by Mr. Webster eighty-six years ago. (Photographed August, 1902.)

can work well together. The first digs the hole; the other, following with the young trees, plants the tree. If the job is large, quite a number of men may be employed; in such case, the two men who started the first row should keep two trees in advance of the men on their right. Two men can plant 1,400 trees in eight hours.

Pine grows very slowly the first ten years, but afterwards rapidly up to about its eightieth year; after that it will grow for two centuries or more, but too slowly to earn good interest on the capital it repre-

NATURAL FOREST OF NORWAY (RED) PINE (*Pinus resinosa*), on the White Earth Chippewa Indian Reservation in Minnesota.



A NATURAL FOREST OF NORWAY (RED) PINE IN MINNESOTA.

sents. In a pine forest, therefore, intended for revenue, eighty years is generally considered the fiscal age of the trees. To derive good revenue the trees should be cut at about that age, at which time they will have reached on an average a diameter of thirteen inches breast high. After removal of the timber where natural regeneration does not prevail, the blank spaces must be planted.

If the forest is extensive one would need in due time to have a skilled forester make a map of it and a working plan, showing the character of surface and soil, location of roads and trails; kinds, localities and age of trees, and all other facts indicating the work necessary to be done to maintain a sustained yield. The forest should be fenced as animals do injury to trees. After a forest crop has been cut enough of the brush to prevent future danger should be burned at a safe time by piling it upon a fire. Fire in a forest should never be allowed to run nor left to smoulder.

A good rule for estimating the number of board feet in a tree is this one, called Doyle's: from the average diameter in inches deduct 4 (as representing slabs); square one quarter of the remainder and multiply by length in feet. For example, suppose a tree is 65 feet high and its average diameter 16 inches; deduct 4 leaves 12 inches, one quarter of which is 3, which squared makes 9; this multiplied by the height of the tree, 65, gives 585 board feet as the contents of the tree.

We have thus seen that by forestry, refuse land can be converted into interest yielding capital as good as government bonds.

In a normal forest the average annual growth on third and fourth rate land amounts to about 280 feet board measure per acre. At that rate we shall expect that our planted forest of red (Norway) and white pine would in eighty years contain on an average 22,000 board feet per acre of merchantable timber, a fairly conservative estimate. I have seen on my native farm in New Hampshire white pine grow to a diameter of two feet breast high in fifty years, but it was on fresh loamy soil, such as is most favorable for the white pine.

We can assume that the expense of planting per acre will be as follows: cost of land, $5, trees, $6, planting, $10, total, $21, being the capital invested in one acre of forest. This sum at 3 per cent. compound interest will amount in eighty years to $223.44. The price of pine stumpage in this country has trebled in the past twenty years, and we can very safely assume that in eighty years its value will at least be $20 per thousand board feet. The acre crop of 22,000 board feet will then be worth $440, so that the average acre of forest will have yielded a net revenue of 3 per cent. on the capital invested, and left a surplus of $216.56 which will have paid the expense of management and taxes. There will also be a little revenue from thinnings and from game.

INSECTS AS AGENTS IN THE SPREAD OF DISEASE

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LESS than fifteen years have elapsed since the scientific world entertained its first definite suspicion that certain human diseases might be spread through the agency of insects. Twelve have gone by since that suspicion became an established fact, and in this short space of time so much has been learned concerning the pernicious activities of these small animals in disseminating disease-causing organisms among man and the higher animals, that the science of preventive medicine can now be applied to many important diseases which were before utterly beyond its reach. Every year brings forth fresh evidence that insects are important factors in relation to public health, and adds to the list of diseases that are partially or entirely dependent upon certain insects for their spread.

A brief statement of the nature of communicable diseases and of the general habits of the kinds of insects that are implicated in carrying disease will serve to define roughly the field of medical investigation which is open to the entomologist. Communicable diseases are invariably due to parasitic organisms in the body which are capable of inducing similar symptoms in other persons or animals if transferred to healthy individuals from diseased ones. Many conditions modify the transfer of communicable diseases; some individuals are more easily infected than others; some may be immune as the result of a previous attack; and, on the other hand, the virulence of pathogenic organisms often varies greatly in accordance with conditions to which they have been subjected previously. A simple method of spread occurs with many diseases, for example typhoid fever and pulmonary tuberculosis. With the former, the *Bacillus typhosus* which is the disease-producing organism, is present in the dejecta of an infected person and may find its way from these to food, carried by flies or otherwise; ingested by a healthy person, it may quite likely multiply and induce a second case of typhoid. With tuberculosis, the tubercle bacillus from desiccated sputum may enter the lungs of a healthy person with dust and there reproduce the disease. As we shall see later, certain insects are commonly associated with the spread of diseases of this type, although from the very nature of such diseases, insects are not exclusive factors, and may be referred to as contaminative carriers.

A second type of communicable diseases differs from the one just

mentioned in that the organism which causes the disease must live for a time in the body of some other animal to undergo certain definite changes before it can again induce the disease in another individual. The most important insect-borne diseases belong to this type, for in the case of man and domestic animals, certain insects and ticks act as the secondary host animals for the organisms of many diseases. Thus, yellow fever is spread only through the agency of a certain mosquito, for in its body alone can the yellow fever organism live and undergo the changes that are necessary before it can be introduced into another patient by the bite of an infected mosquito. Malaria belongs to the same category, for it spreads only through the bite of certain mosquitoes that obtain the organisms with their meal of blood, and then afterwards inject into the blood of another person, a later stage of the malarial parasite which has developed meanwhile within the mosquito.

Diseases in which certain insects act as specific carriers are most numerous and prevalent in the warmer parts of the world, although temperate regions are by no means free from diseases of this kind, which may be referred to as the inoculative type.

Among insects which disseminate pathogenic organisms without any specific association, the common housefly is without doubt the most important. The rank of the fly in this unenviable profession is due to several facts in its life-history which render it eminently suited to act as a vector for several diseases such as typhoid fever, diarrhœa, dysentery, summer complaint of children, etc. The eggs of the house fly are laid preferably in horse manure, upon which the larval stages or maggots feed, but human excrement serves equally well, and when exposed is very likely to provide food for a brood of fly maggots. Less than two weeks are required for the larvæ to mature, and after a short resting stage of two or three days the adult flies emerge from their bed of filth. At this time they may quite possibly bear in their alimentary tract bacteria derived from their larval food. Usually, however, they are quite clean when hatched, in spite of the surroundings whence they have come. They do not long remain so, however, for they feed upon animal and human dejecta of all sorts, garbage and other fermenting material, and if still hungry invade markets or houses, where they may leave upon food any bacteria brought upon their bodies, legs, mouth parts or wings. In addition, their excrement deposited as "fly specks" may contain virulent pathogenic bacteria, if they have had access to matter from which these could be obtained.

This, in brief, is the status of the house fly as a disease carrier and it is readily seen why filth diseases are the ones naturally spread by this insect. Attracted to the nursing bottle or to the baby's mouth they may infect him with bacteria of any of the numerous enteric troubles known as summer complaint. If they have had access to the dejecta of a person

suffering from typhoid fever, or to those of a chronic carrier of this disease, they may deposit the virulent bacteria upon food that later finds its way into our own bodies. Bacillary dysentery may be spread in the same fashion as well as many other gastro-enteric infections.

The house fly occurs practically throughout the entire civilized world and under all conditions is a continual menace to public health. In rural communities, however, where the proper disposal of waste matter of all kinds is most difficult, the importance of these insects is correspondingly increased.

The house fly is not the only insect which may act as a carrier of typhoid, for Dutton has shown experimentally that this may be spread by the bed-bug. These insects become infected through feeding on the blood of a person in the acute stage of the disease and for at least twenty-four hours retain the bacteria in a sufficiently virulent condition to inoculate a second person whom they may bite. That other biting insects such as fleas and mosquitoes may act in the same way is as yet unproved, but is by no means improbable.

Several other species of flies appear regularly in houses, but in far lesser numbers, and none exhibit to such a marked degree the peculiar tastes of the house fly, which wanders back and forth from filth to food, feeding on each in turn. In this method of feeding lies the danger of infection by house flies; they are equally fond of clean and filthy materials, and their frequent migrations from one to the other multiply their opportunities to pick up pathogenic organisms that may be later deposited upon foods.

The flea is another domestic insect which was looked upon only as a nuisance until it was shown that certain kinds of fleas are agents in spreading bubonic plague. The most terrible epidemics of which we have any historical record have been those of plague, or "black death." One swept from Egypt in the sixth century before the Christian era and invaded Europe and Asia, where it raged for sixty years. A similar one spread through the whole known world in the fourteenth century and is thought to have caused over twenty-five million deaths before it subsided.

In 1898 Simond suspected fleas as agents in the spread of plague and his suspicions have since been fully justified by Verjbitski and others. Plague is common to rats, certain other rodents and man, and is usually carried to man by the bites of fleas which have become infected from plague-stricken rats. The flea most commonly concerned is the rat flea, *Læmopsylla cheopis*. The transfer of plague bacteria is mechanical in nature, and other fleas, bed-bugs, etc., may also act as carriers, although far less commonly.

The plague bacilli (*Bacillus pestis*) appear only in fleas and bugs which have bitten affected persons or rats twelve to twenty-six hours

previous to death, for after this time the bacilli do not occur in the blood. The vitality and virulence of the bacilli are preserved for nearly a week at least and sometimes fully a month; and there is actually an increase in their number during the first few days. Infection from these insects may then occur through their bites, if they contain extremely virulent bacilli, but probably occurs more commonly by the insects being crushed *in situ* after they have punctured the skin. Plague is confined more generally to the tropics and in recent years has threatened to become epidemic in the United States only in the region bordering San Francisco, Cal. Prompt measures of repression, based on a knowledge of the manner in which the disease spreads, have, however, been very successful and future wide-spread epidemics are not to be expected.

Plague is primarily a disease of rats, and its occurrence as a human disease is rather secondary, so nearly so that it can almost be said "no rats, no plague." On this account the destruction of rats is the first prophylactic measure to be undertaken for the suppression of plague, since this is much more readily accomplished than the destruction of the fleas directly. In parts of California the wild ground squirrel has become infected with plague from rats and presents a menace to the human population, although apparently not so great a one as the rat.

Another disease that has very recently been demonstrated to be insect-borne is typhus fever. This should not be confused with typhoid; it is a very different disease, occurring in the tropics and colder regions alike, and usually associated with dirty, unsanitary surroundings. On this account, it is becoming less prevalent in civilized countries every year, but has at times in the past claimed many victims. During our own civil war, the inmates of army prisons suffered greatly from the ravages of typhus fever, and similar conditions of crowding many people together in filthy surroundings have long been known to be favorable for the development of typhus fever epidemics. We now know through the researches of Ricketts and others that typhus is carried by vermin, the body louse, *Pediculus vestimenti,* acting as the vector. Thus the etiology of typhus has suddenly been made clear and we are in a position to formulate measures for prophylaxis and quarantine which will prevent the development of the disease in epidemic form. There is much yet to be learned; perhaps other insects also may act as carriers, but there can be no doubt that typhus is almost exclusively insect-borne.

Another disease which has puzzled the medical profession for centuries is a peculiar malady known as pellagra. Pellagra develops very slowly, and the origin of individual cases is correspondingly difficult to trace. It is also usually rather erratic or sporadic in occurrence, but appears to be rapidly increasing in prevalence in many parts of the United States. At one time it was thought that pellagra was contracted

through eating moldy corn or corn products, and investigators went so far as to describe a certain fungus as the specific cause of the disease. This hypothesis was never satisfactorily in accord with the facts, and has been abandoned very generally in favor of a belief that pellagra is insect-borne. This has not yet been sustained by actual proof, and is far from being generally accepted, but Sambon and others have adduced much evidence to show that the "black-fly" (*Simulium*) may be the carrier for the virus of pellagra. These flies are widely distributed throughout the world, always occurring in proximity to rapidly flowing streams of water in which the larvæ live. The adults, though small, are vicious biters. They appear mainly in the spring, more rarely in the fall, and agree in seasonal distribution with the incidence of pellagra. The causal organism has never been found and is evidently an ultramicroscopical or filterable virus.

One of the best known insect-borne diseases, and one which is of great importance in many parts of our own country is malarial fever, variously termed ague, chills and fever, etc. This was the first human disease traced directly to insect carriers and gave the impetus which has led to the unraveling of the facts connected with other insect-borne diseases. There are many types of malarial fevers, due to a number of similar but different blood parasites and the disease is most common in tropical regions, although in our own country it extends well into the northern states, even quite commonly into Massachusetts. The protozoan blood parasites that cause malaria were first demonstrated many years ago, in 1880, by a French surgeon, Laveran, who discovered them in the blood of persons suffering from malaria. Five years later an Italian, Golgi, distinguished three kinds, each associated with one of the more familiar types of malaria. They were found to go through a regular life cycle in the red blood corpuscles and, from analogy with other known Protozoa, it was suspected that in addition to their non-sexual generations in the human blood there must be a sexual development in some cold-blooded animal. Manson was led to suspect that some insect might be the secondary host and, working on this hypothesis, Ross in India first found the malarial parasites in a certain kind of mosquito in 1898. He had worked for nearly three years on a common mosquito belonging to the genus *Culex* without result, but finally in a mosquito of the genus *Anopheles* was able to trace the development of the parasite. His epoch-making discovery has been since amply confirmed and extended by experimental proof till we now know that the various types of malarial blood parasites complete their life-cycles in anopheline mosquitoes, the latter acting as the sole carriers of the disease.

The details of growth and development of these parasites, which belong to the Protozoan genus *Plasmodium,* are extremely interesting, but far too complicated to discuss briefly. In general it may be said

that the blood of persons suffering from malaria contains the parasitic organisms, and that these, on being taken into the stomach of the proper kind of mosquito, undergo certain changes and later penetrate the wall of the stomach to form vesicular swellings. Within these they multiply, and finally on the bursting of the nodule are set free in the body cavity and find their way to the salivary glands. After becoming infected, a period of twelve to twenty days are required for these changes in the mosquito. Then for a period of several weeks the virulent organisms remain in the salivary glands and if the mosquito bites a second person the parasites are introduced with the salivary secretion, through the puncture into the circulation. Here they multiply and produce another case of human malaria, which develops from ten days to three weeks after inoculation.

As previously stated, only certain mosquitoes can transmit malaria, for when the parasites are ingested by other species of mosquitoes they do not continue their development, but die without passing through the stomach into the salivary glands. In the United States only one form, *Anopheles maculipennis*, is capable of harboring malaria, but in other parts of the world, especially in the tropics, other species of *Anopheles* and related genera act as hosts for the several kinds of *Plasmodium*.

Although in temperate regions the number of deaths from malaria is rather small, in spite of the wide-spread occurrence of the disease, the economic loss is very great, due to the debilitated condition which invariably occurs in the population of malarial districts. In the tropics, however, malaria in its various forms causes an enormous number of deaths and predisposes its victims to so many other dread diseases that it ranks as perhaps the most important human disease.

Fortunately prophylactic measures against malaria are not difficult, although they have been shamefully neglected in our own country. They consist in the elimination of anopheline mosquitoes, which is best accomplished by the destruction of mosquitoes in general. The larval or preparatory stages of anopheline, and of practically all other mosquitoes, are passed in the water of small quiet ponds, puddles, exposed vessels containing water, rain-barrels, etc., and it is during this period that they are most easily controlled. This is accomplished by oiling the water with either crude or refined petroleum or with some miscible oil. The petroleum forms a film over the surface of the water through which the larvæ can not extrude their breathing tubes and they are thus suffocated. The application of miscible oils is efficacious, but attended with some danger, since it destroys fish and predatory insects which are themselves some of the most important natural enemies of mosquitoes. Very frequently even oiling is not necessary, as much swamp land may be permanently freed from mosquitoes by very simple systems of drainage ditches which prevent the accumulation of the stagnant water in which the larvæ occur.

Anti-malarial work of this sort has been undertaken and successfully prosecuted in many parts of the world; in the Federated Malay States, in the Suez Canal region, at Havana, Cuba, and in the Panama Canal Zone. Many other regions might be mentioned, but we must look in vain for such concerted and sustained work in the United States. Attempts have been made by many entomologists and public-spirited citizens to inaugurate measures against mosquitoes on account of their relation to malaria, but with the excepion of the most successful work accomplished by Smith in New Jersey and by others on Long Island little has been done to aid the efforts of the energetic few. We have, however, reason to believe that such apathetic contemplation on the part of the American public will some day develop into an active interest, and that the population of our extensive malaria-ridden areas will gradually see the possibilities of improvement in public health through the destruction of the malarial mosquito.

Another mosquito-borne disease which has aroused more interest in America on account of its spectacular appearance and higher mortality is yellow fever. This is due to a filterable virus, concerning the nature of which we can only speculate at the present time, although enough has been ascertained through experimental work to demonstrate that the virus is a living organism which undergoes a development of definite periodicity in mosquitoes of a single species known as *Stegomyia calopus*. This mosquito enjoys a very wide distribution in many parts of the world, mainly in the tropics, but also extends into the warmer temperate regions. Yellow fever is not so extensively distributed, being absent in many places where *Stegomyia* occurs, but it is nevertheless present in many parts of the tropics in both hemispheres and all that is necessary for the development of a possible epidemic in a region where *Stegomyia* occurs is the introduction of a human case in the early stages of the fever.

The larval habits of *Stegomyia* are in quite marked contrast to those of *Anopheles*. The adults are strictly domestic mosquitoes and occur almost entirely in the neighborhood of human habitations. Their larvæ occur in the same places, breeding preferably in vessels containing small amounts of water, rain barrels, cisterns, stray tin cans filled with rain water, etc. On this account, extermination work against the yellow-fever mosquito resolves itself mainly into the examination and treatment of cities, towns and the immediate environment of smaller settlements.

A *Stegomyia* feeding upon the blood of a person suffering from yellow fever becomes infected only during the first three or four days after the onset of the fever; later than this mosquitoes do not obtain the virus. An incubation period of at least twelve or fourteen days in the mosquito is now necessary before the mosquito can infect a second

person, after which the *Stegomyia* remains infectious for a long period and may be responsible for a series of new cases. These facts were first discovered during the summer of 1900 by a Yellow Fever Commission consisting of Drs. Reed, Carroll, Lazear and Agramonte, of the U. S. Army. Two of these men, Carroll and Lazear, allowed themselves to be bitten by infected mosquitoes, and Lazear died from a severe case of fever thus contracted.

Little further has since been learned of the etiology of yellow fever, but wonderful strides have been made in the application of these simple facts for its eradication. In Cuba, where the commission conducted their investigations, the first attempts were made, and in 1902 yellow fever had been entirely eliminated in Havana. Other West Indian islands were formerly badly infested with yellow fever, but at the present time there is little more danger from this disease there than in the United States. Rio de Janeiro was once a hot bed for yellow fever, but it too has yielded to the destruction of mosquitoes and the screening of patients, till after a six years' fight, the fever has vanished. Still more remarkable are the results accomplished in the Panama Canal Zone under the direction of Dr. Gorgas. Here the warfare against yellow fever has gone hand in hand with anti-malarial work and the isthmus has been transformed from a veritable death-trap to a condition which compares favorably with that of any region on earth.

Our own country has suffered from yellow fever in the past, mainly in the south, but extending to southern Illinois in 1878, to Philadelphia in the terrible epidemic of 1793 and even to Boston and into interior New England towns in the earlier days. The last epidemic occurred during the summer of 1905 in New Orleans, where the application of rational methods rapidly checked the spread of the disease and resulted in its complete eradication long before cold weather. The success of this campaign has undoubtedly sounded the death knell of the yellow fever epidemic and panic in the United States, for New Orleans has amply demonstrated what may be accomplished in the control of an epidemic by an efficient group of workers, backed by a sympathetic public and supplied with reasonable funds.

Rocky Mountain spotted fever, an important human disease which occurs in certain parts of the Rocky Mountain region in the northern United States, has been shown to be insect-borne. In this case the vector is a tick, not a true insect, but a member of the arthropod group Acarina, whose members are so much like insects in many ways that it is hardly necessary to make any distinction in the present discussion. In 1902 Wilson and Chowning suggested that ticks might carry this disease, and four years later Ricketts definitely proved such to be the case. Spotted fever occurs in its most severe form with 70–80 per cent. mortality in western Montana, but extends into several other near-by

states in a much milder form with only 5 per cent. mortality. A common wood-tick of that region, *Dermacentor venustus,* seems to be the only carrier under natural conditions, but recently Maver has shown experimentally that other ticks can transfer the virus. One of these is *Amblyomma americanum,* a common form in the eastern states, and two others are members of the genus *Dermacentor* which occur also in the east. Whether spotted fever will eventually become established beyond its present range must remain a matter of conjecture, although there appears to be nothing that precludes such a grave possibility.

One of the most important insect-borne human diseases which does not exist in the new world is African sleeping sickness. In recent years this malady has decimated the native population in certain parts of eastern equatorial Africa and any extension of its range would be most serious. It seems very unlikely that America will ever have to face an epidemic, for the introduction of sleeping sickness together with its carrier is not at all probable, and the possibility of its becoming established, even after introduction, is still more remote. As is well known, sleeping sickness depends for its spread entirely upon certain biting flies known as tsetse-flies belonging to the same family as our common house fly and stable fly. The genus *Glossina* in which these flies are included is restricted to the African continent, but is there represented by a number of species, several of which have been shown to act as carriers for trypanosome diseases in animals. One only, *Glossina palpalis,* is known to carry the trypanosome of human sleeping sickness, *Trypanosoma gambiense.* The disease appears to have been originally endemic only in West Africa, but was found in eastern equatorial Africa something over ten years ago, and it is in this latter region that its ravages have been so pronounced. Owing to certain peculiarities in the habits of the tsetse-flies, the distribution of sleeping sickness is limited to very definite areas in the region where it occurs. The fly, which has a sharp needle-like beak for sucking blood, resembles our own stable-fly (*Stomoxys calcitrans*) in general appearance but is considerably larger, measuring about half an inch in length. It is found only in the dense brush which grows along the edges of streams, ponds and lakes. In such places persons and animals may be bitten by the flies and it is exclusively through such bites that these insects may obtain virus of sleeping sickness from the blood of a person or animal suffering with the disease. Should the fly obtain a meal of blood containing trypanosomes, these may multiply in the body of the fly, although not always, for only about one in twenty of such flies becomes infectious. A considerable period must now elapse before the infected fly is in condition to inoculate a new patient, usually thirty or forty days, but after this for at least seventy-five days it remains infectious, and may introduce the trypanosomes into the blood of any animal upon which it feeds during this period.

The tsetse-flies develop in a very different way from most insects. The female does not deposit her eggs, but a single one develops to the fully grown larval condition before being deposited. This larva soon pupates in the shade beneath the brush bordering the water where it has been dropped by the parent fly, and later emerges in the winged adult condition. The pupæ require such moist shade, and it is apparently for this reason alone that the flies never occur away from the immediate vicinity of the water. As a result of its method of development, the tsetse-flies do not multiply rapidly, and under favorable conditions only one larva is produced in a ten-day period.

The trypanosome of sleeping sickness was discovered by Bruce in 1902 and a year later the role of *Glossina palpalis* in its transmission was proved. Since then much energy has been expended in attempting to stamp out the disease by every possible means. It was thought at first, that by moving all the natives back from the edges of the water the flies thus left without opportunities for re-infection, would become free from trypanosomes, and that by isolating and treating cases of the disease in fly-free areas it would be possible to eliminate it entirely. In conjunction with this, the cutting of brush, especially about boat landings and watering-places, has been practised as far as possible. Contrary to expectations, it has been found that even after three or four years, infected flies still occur along the uninhabited shores. This led to experimentation upon animals and it is now known that various wild antelopes as well as certain domestic animals may act as reservoirs for the virus of sleeping sickness which may thus persist in the complete absence of any human subjects. As a result of this discovery the great difficulties of combatting the disease among the ignorant African natives have been vastly increased.

The regions surrounding the Mediterranean Sea are the centers of distribution for a very interesting, but far less dangerous insect-borne disease known as phlebotomus fever. In this case the carriers are minute gnat-like flies of the family Psychodidæ known as *Phlebotomus papatasii*. These insects are semi-aquatic in the larval condition, occurring in damp situations, drains, cellars, etc., where they feed on plant matter. The adult is a vicious biter in spite of the fact that it is scarcely over one millimeter in length. It rarely bites except at night, following the habits of certain mosquitoes in this respect. The specific cause of phlebotomus fever is not known, but it has been shown to be an invisible virus. At the present time it is impossible to state whether other insects may play a part in its transmission, although such does not seem probable. We have at least one species of *Phlebotomus* in the United States and it is possible that it might act as a vector should the disease be introduced into our country, although it would seem that such a

possibility would have been realized already if it were likely to occur, for cases of this common European fever must undoubtedly have been imported.

We have already referred to ticks as carriers of spotted fever in this country. Another important disease, or group of closely similar diseases, known as relapsing fever, is known to be tick-borne. This malady is due to a very small spirochæte, a protozoan organism known as *Spirochæta recurrentis.* In acute human cases of this disease these are present in the peripheral blood from whence they may be withdrawn by ticks. Within the alimentary tract of at least some species of ticks the parasites undergo a sort of development which is not well understood, entering the Malpighian tubules or other parts of the body and later assuming a somewhat different spirochæte form. Infection of another person may then occur from a subsequent bite by the infected tick, the virus not passing into the body from the salivary glands or mouth, but entering the wound after having been excreted by the attached tick. As occurs with the tsetse-fly carriers of sleeping sickness, only a part, in this case about one third, of the ticks feeding upon a person with relapsing fever become infected themselves. Of those which do, however, some may transmit the infection to their offspring, which are then capable of infecting man with the virus thus received. Relapsing fever is very widely distributed, mainly in warm countries, although in Europe it has occurred in epidemic form as far north as St. Petersburg. The etiology and method of dissemination of the African type appear to be best known. A common tick, *Ornithodoros moubata,* was first found to act as vector and was until very recently believed to be the only carrier. Now it has been demonstrated that other ticks may act in the same way, and there is a possibility that other carriers may exist, probably in the form of blood-sucking insects.

Relapsing fever has been occasionally reported from the United States, but has never become established.

Among the less important insect-borne diseases is a very widespread tropical fever known as dengue which occasionally spreads into temperate regions in epidemic form. This is due to the presence in the red blood corpuscles of a protozoan smaller than the malarial parasite, probably a spirochæte of some sort. However this may be, we know from experimental tests that dengue may be spread through the agency of certain mosquitoes. The widespread *Culex fatigans* is capable of transmitting the infection and there is good evidence to incriminate the yellow fever mosquito, *Stegomyia calopus.* Dengue is quite common in the southern United States, where in the minds of many people it is confused with malaria. It is less serious, however, although an even more unpleasant ailment to endure.

The same *Culex fatigans* has been shown to be at least partly respon-

sible for the transmission of a parasitic disease of the tropics known as filariasis. The direct cause is a nematode worm belonging to the genus *Filaria* which is present in the circulation and lymphatics of the infected person. In the late stages of the disease the microscopic larval worms occur abundantly in the blood. For some unexplained reason they remain in the deep-seated blood vessels during the day, but usually appear more abundantly in the peripheral circulation during the night. Here they are readily obtained by mosquitoes with their meal of blood. In the alimentary canal of the mosquito the larval *Filaria* discards a sheath-like envelope which has previously invested it, and works its way through the wall of the stomach into the thoracic muscles where it increases greatly in size and finally migrates to the base of the proboscis. From two to three weeks are necessary for this metamorphosis, and for some time longer the *Filaria* may remain in the proboscis awaiting its opportunity to enter another person through the wound occasioned by the mosquito's beak. Once they have been transferred to their human host, the parasites enter the lymphatics where they attain sexual maturity and give rise to the abundant microscopic larval *Filarias* that reenter the circulation to await ingestion by another mosquito.

Filariasis is most common in equatorial regions, but extends less commonly into the subtropics. The parasites themselves do not ordinarily cause great inconvenience, but their presence in the lymphatics may clog these vessels to such an extent that secondary swellings may be developed in the limbs or other parts of the body.

Several insects have been associated with a peculiar tropical disease of the old world, variously known as kala-azar, dum-dum fever and leishmaniosis. In this case the organism is a flagellate protozoan, *Leishmania donovani,* of which there are possibly two forms, one producing a children's disease termed infantile kala-azar and the other the true leishmaniosis of adults. It has been shown that among domestic animals the dog at least is susceptible, and other animals may be also. In 1907 Patton discovered various stages of the *Leishmania* parasites in bed-bugs that had fed on persons suffering from kala-azar and this insect has been considered to be one, if not the exclusive, carrier. Very recently, however, some doubt has been expressed regarding the rôle of the bed-bug and a certain reduviid bug has been suspected. There seems to be no doubt, however, that kala-azar is insect-borne.

The diseases which we have enumerated are the more important insect-borne ones that affect man. A number of others of greater rarity or of minor nature are known to be carried regularly or occasionally by various insects, and many others are now being investigated in the light of present knowledge to ascertain if they, too, may not be spread by insects. It seems probable that flies may take some part in the dissemination of the bacilli of leprosy, although to how great an extent

can not be said, and the same is true to a greater or less degree of cholera, pink-eye, yaws, syphilis, and many other diseases which can not be considered as typically insect-borne.

One other disease which has been increasing at an alarming rate in our own country during the past several decades is infantile paralysis. This malady occurs in certain parts of Europe, whence it is probable that it was brought to America. As a rule it affects children during the first few years of life and, although the mortality is not so very great, a majority of the children affected are left permanently lame after recovery. The virus of this disease is an ultramicroscopic organism which causes lesions of the spinal cord that sometimes lead to paralysis. At the present time it appears probable that infantile paralysis is insect-borne, and it has been suggested by Brues and Sheppard that the stable fly, *Stomoxys calcitrans,* acts as a carrier of the virus,[1] although it is quite possible that some other insect also may be concerned.

No account of insect-borne diseases, however brief, could be complete without some reference to animal diseases. A few of these have already been referred to incidentally as affecting both man and animals, and it is quite likely that other human diseases whose etiology is at present obscure, will in the future be shown to bear some relation to those of animals. Apart from this, the economic loss occasioned by such affections of domestic animals is enormous, although it is in great part preventable.

A wide-spread disease of cattle in the southern part of the United States, known as splenetic fever, or "Texas fever," is the most important insect-borne animal disease that occurs in this country, and is particularly interesting since it was the first disease of any kind shown to be carried exclusively by insects or ticks. It occurs very generally throughout the gulf states as far north as the thirty-sixth parallel of latitude and is the cause of immense pecuniary loss to this region, not only on account of the cattle lost, but as a result of the greatly weakened condition of the animals in general. Southern cattle are usually immunized by an attack at an early age, but northern animals die in large numbers when exposed to the disease.

Smith and Kilborne showed, in 1893, that the protozoan blood-parasite, *Piroplasma bigeminum,* which Smith had discovered several years earlier to be the cause of the disease, is carried by ticks. The common cattle-tick of the southern United States, *Margaropus annulatus,* acts as the exclusive vector, becoming infected during its period of engorgement when feeding on the blood of a diseased animal and then trans-

[1] Since the above was written, it has been shown by experiments with monkeys by Rosenau and Brues, that *Stomoxys* can actually transmit this disease, and their results have been confirmed by Anderson and Frost.

mitting the *Piroplasma* through its eggs to the young ticks of the next generation. These may feed on healthy animals the next season, conveying to them the parasites that have been handed down from the mother tick.

Several similar diseases of cattle occur in other parts of the world. In Africa, related forms of *Piroplasma* carried by ticks are the cause of redwater, East Coast fever, Rhodesian fever, and in various parts of the world other piroplasmoses have been observed in many animals.

Spirochætosis in animals, due to organisms similar to those producing relapsing fever, is well known. The most familiar example is probably a disease of fowls which is carried by *Argas miniatus,* a common tick which infests these birds.

Trypanosomiasis is a general term for diseases like sleeping sickness due to trypanosomes and there are many diseases of this type, among which may be mentioned an old-world affection of horses known as Surra; an African one, Nagana, that attacks other domestic animals as well; and a South American type termed Mal de Caderas. Flies are the insects implicated in the transmission of these diseases, mainly the large tabanid horseflies and the smaller stable flies of the genus *Stomoxys.* Surra was recently introduced into the United States, but was successfully stamped out before it had become established.

Among bacterial diseases of animals, anthrax may be mentioned as one which is sometimes transmitted by biting flies, the insects acting as mechanical or contaminative carriers only.

The foregoing enumeration of insect-borne diseases is by no means complete. Indeed, it would be well-nigh impossible to make it so, in view of the rapid strides which are being made at the present time toward a knowledge of these many problems which bear on the question of public health. New discoveries are being rapidly announced in all parts of the world, and while it is difficult to see how the fundamentally important revelations of the past fifteen years can be equalled in the near future, we should be very unwise to predict that they will not be exceeded.

THE GENESIS OF INDIVIDUAL AND SOCIAL SURPLUS

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LIFE implies surplus energy. No organism can exist for any appreciable period without experiencing the fact that its environment is more favorable or more hostile to its life-activities at one time than at another time. Strength that just suffices to resist some special stress thus yields a surplus when that stress is over. Protozoa and men alike are subject to vicissitudes. At times they barely manage to survive. Again their energy exceeds their needs.

How variations increasing surplus energy are caused no man has definitely shown, though Metchnikoff may yet succeed in proving why the surplus disappears. We merely know that surplus does exist in varying degrees and that its rise and fall depend on measurable facts. We know, too, that the greater the surplus the greater the freedom men have to pursue the higher ends of life or, if they choose, the lower.

The fact that surplus energy exists and that important consequences result therefrom has been often emphasized. Shiller presented the idea in his discussion of esthetics a century ago, and even Groos, though severely criticizing Spencer for connecting the idea of imitation with the overflow of energy, admits the presence of surplus energy to be "the *conditio sine quâ non* which permits the instincts to be so augmented that finally . . . they . . . permit indulgence in merely sportive acts." Patten has even proclaimed a "new basis of civilization" upon the assumption that a social surplus now exists whereby a "pain economy" has been replaced by a "pleasure economy." These writers, however, and others who have dealt with the subject appear to have been interested primarily in demonstrating that certain phenomena or consequences result from an existing surplus. To a limited extent only do they attempt to show upon what conditions the amount of surplus energy in any given case depends. The way appears open, therefore, for a discussion of the clearly marked stages in the increases of surplus energy which have taken place in the evolution of the higher from the lower forms of life and in the evolution of man himself. Such a discussion may be expected to throw light upon at least three problems of more than academic interest. These are the questions: why man in a comparatively brief period of time (as reckoned in geology) has far outstripped competitors; why sociologists should consider psychological

facts of more importance than biological in their interpretations of society; and why it is reasonable, for the present at least, to hold the eugenist's fear of decadence a trifle overdrawn.

Surplus energy, as used in this paper, means the amount of energy available for life-processes which is possessed or obtainable, by any organism, over and above the amount which is necessary for survival at any given time.

Surplus energy, in this sense, assumes many forms. Bodily vigor and long life are not the only manifestations of it. Such material goods, also, as are immediately available for restoration of depleted bodily vigor come under the general heading. Moreover, any structural or other changes in an organism which improve its chances of survival, increase the surplus. The development of useful instincts and the discovery of useful methods of controlling nature and producing wealth—these, too, increase the surplus. Bettered social organization plays its part as well. In fact, in close analysis, every trait and every act of any unit of a group in some way affects the surplus. It is evident, therefore, that only the more important phases of the subject can be considered here. The term social surplus follows directly from the meaning of surplus energy. The social surplus is merely the sum total of surplus energy existing in the individuals composing a social group or immediately available to such individuals.

What were the first steps in the development of surplus energy in the long series of organic changes that led to the evolution of the higher animals and man, none can say. If it is permissible to hold, however, that the earliest ancestors of man were similar in character to the lowest forms of animal life now existing on this planet, we may at least surmise the general character of those early advances.

Consider, for a moment, the great advantage over the lowest protozoa, certain structural differences give that large group of single-celled animals called Ciliata. The microscopic *Amœba proteus*, which may be taken as representative of the very lowest animals, is structurally most simple. Its form is irregular and is continually changing in response to stimulation. Although the internal substance of its body shows some differentiation, there is nothing remotely resembling specialized sense organs. According to Jennings, one of the foremost authorities on the behavior of the lower organisms, the amœba has three characteristic reactions to stimulation. These are, the negative, the positive and the food-taking reactions. The first is a contraction of the part of the animal stimulated when, for example, it comes into strong contact with a solid obstacle. The negative reaction may cause movement in a direction opposite to the point of stimulation. A positive reaction to solid bodies occurs when a pseudopodium is pushed forward in the direction of the stimulus and the animal moves toward the solid. The

negative reaction is useful in avoiding obstacles; the positive in securing contact with food. The food-taking reaction is the enveloping of food by throwing pseudopodia about it. These three reactions together with the ordinary crawling locomotion and the throwing out of pseudopodia in search of a solid on which to crawl, constitute the entire variety of *Amœba's* experiences as displayed in behavior.

The structure of the Ciliata is much more complicated and in certain respects marks a distinct advance in equipment for the struggle for existence. *Paramecium* may represent the type. In this animal not only are the cilia modified locomotory structures, but there is a definite region for food taking. A groove extends obliquely down one side of the body, terminating at its lower end in a mouth. It is to the cilia, chiefly, however, that *Paramecium* owes its superiority over *Amœba.* These are usually inclined backward and their stroke then drives the animal forward. The most interesting characteristic of the stroke is its obliqueness so that *Paramecium* always rotates on its long axis, whether it moves forwards or backwards. In consequence of this fact, according to Jennings, *Paramecium* solves the problem of how an unsymmetrical organism, without eyes or other sense organs, may, nevertheless, maintain a definite course through trackless water. Not even man succeeds in maintaining a straight course under similar but simpler conditions. On the trackless snow-covered prairie the traveler without compass, landmarks or other guide wanders in circles, though it is possible to err only to right or left, not up and down as in the water.

Paramecium, by rotation, compensates for any wandering by equal wandering in the opposite direction. Nature anticipated the modern rifle by several æons. With this equipment whenever a *Paramecium* reacts negatively to some stimulus it is able to continue swimming in a direction away from the stimulus until the stimulation ceases. Through the additional power of slightly accentuating the rotation-swerve the animal is enabled to swim in various directions and to remove itself successively from many different environmental conditions, until it has found what Jennings terms the "optimum." This behavior Jennings characterizes briefly as a "selection from the environmental conditions resulting from varied movements." It is in fact a "trial and error" method with selection of the optimum—a method not unknown to man himself.

This characterization of it, however, may seem to imply too much. *Paramecium* "tries" over and over again, but what is "tried" is always the same thing—there seems to be no profiting by experience. Whether the response of *Paramecium* to stimulation is conditioned in any degree by subjective phenomena, or is even accompanied by them, is a disputed point. Even if present there remains the further question as to the extent such subjective phenomena may be considered similar

to those of the human mind. With respect to the development of surplus energy, however, it matters little whether Jennings's affirmation or Loeb's denial of consciousness is right. It is perfectly clear that the structural change represented by the difference between *Amœba* and *Paramecium* permits greater adaptation of the individual to its environment and, other things equal, tends to permit a greater expenditure of energy in non-sustaining activity. Further improvements in structure encountered as we proceed higher in the scale of evolution likewise imply greater adaptation and still greater surplus.

Before leaving *Paramecium* to discuss behavior of a distinctly more advanced type one more point of special interest to the sociologist must be noted. This is the fact that *Paramecia* in their individual efforts to find the optimum environment are brought into physical proximity. Further, it has been demonstrated that for certain individual *Paramecia* the optimum seems to be created, other things being equal, by the presence of carbon dioxide. Inasmuch as carbon dioxide is produced by the *Paramecia* themselves, this means that such *Paramecia* not only tend to form groups, but indirectly to influence the behavior of each other. If subjective phenomena accompany response to stimulation by carbon dioxide we have here a state of consciousness modified by the presence of organisms of like kind, even if there is, strictly speaking, no consciousness of kind—that is, even if there is no recognition of the presence of another of its own kind by the animal. The formation of groups by *Paramecia* as a result of their own production of carbon dioxide, according to Jennings, explains many peculiar phenomena in their behavior. For example, *Paramecia* in a solution of carbon dioxide react to other agents in a manner entirely different from the action of individuals in water not containing carbon dioxide. Now membership in a group is often an important protection to the individual. It is, therefore, often a factor in survival and is of importance in the production of a surplus.

The important facts to be noted up to this point are, first that change in structure may mean more complex behavior and an increased surplus, and second, that congregation if not association modifies both behavior and safety and this also affects surplus.

In *Stentor roeselii* there enters a new factor affecting surplus. This is the modification of behavior because of past experience. *Stentor roeselii* is a colorless or whitish trumpet-shaped water-inhabiting animal consisting of a slender stalk-like body bearing at its end a broadly expanded disk. The surface of the body is covered with cilia. The smaller end of the body is known as the foot and at this end fine pseudopodia are sent out by which the animal attaches itself. The lower half of the body is surrounded by the so-called tube or sheath formed by a mucus-like secretion from the surface of the body. If, now, some such

substance as carmine ink be introduced into the water so as to reach *Stentor's* disk there are several reactions. At first the normal movements of the cilia which cause a current of water to flow toward the animal's mouth are not changed. The particles of carmine ink enter the mouth and thence penetrate the internal protoplasm. If the cloud becomes dense, however, the animal presently bends aside. If this reaction is not effective in getting rid of the particles it is repeated. If failure still results the ciliary movements are suddenly reversed to produce a current of water away from the mouth. This reversal is brief but, if no improvement is effected, it may be repeated many times in rapid succession. Next, contraction within the sheath may occur. By this contraction the animal escapes stimulation entirely, but it also obtains no food. Usually the animal extends itself again in less than a minute. If particles of carmine are again met *Stentor* no longer reacts in the milder ways employed at first, but contraction occurs at once. This may be repeated many times, each period of retirement lasting longer than the preceding one. Ultimately the animal contracts repeatedly and violently while still encased in its tube. It thus finally detaches its foot from its moorings, leaves its tube, swims away, attaches itself elsewhere and forms a new sheath in a new and more favorable environment.

This behavior differs from that of *Paramecium* in a radical way. *Paramecium,* except when fatigue or other cause reduces surplus energy, always reacts in the same way to the same stimulus. *Stentor* reacts in different ways. As Jennings puts it "the change in reaction must be due to a change in the organism" itself. In any event the present readiness of this organism to react in one of two or more possible ways depends on its past history. The animal profits by experience. The change in reaction is regulatory, not haphazard. Something akin to habit has appeared. This clearly marks the saving of much energy that otherwise would be spent in useless attempts to avoid injurious conditions. There is less waste and more surplus, more chance of survival and a greater length of time during which the animal possesses a surplus of energy over the minimum necessary for survival.

To trace the gradual development of creatures more complex in structure, and in consequence more complex in behavior, might be interesting, but if the recent work of observers of animal behavior is to be trusted no new principles are involved until the primates themselves are approached.

Throughout the period marked by this interval, however, countless changes in the structure, in the production of new reflexes, in the modification of instinctive behavior by the formation of habits, perfected the adjustment of individuals to the physical environment and their accommodation to their fellow creatures. Definite complex com-

binations and series of combinations of reflex reactions in the presence of a series of complex stimulations appeared and these in turn were rendered more complex by the development of habits based on individual experiences repeated anew by every generation. Each useful instinct and every valuable habit made the individual organism more efficient, lessened the effort necessary to live, increased surplus energy.

As man was approached, however, the factor of habit became more and more important. Some hint of how this occurred may be gained from every-day observation. It is a commonplace that exercise of muscles that are fitted to perform certain functions renders the habitual exercise of that function as certain in its operation as is a pure reflex. Young birds awkward in their first flight become expert rapidly. Beasts of prey by trial and error eliminate unsuccessful modes of attack. Before our eyes instinctive actions become modified by experience to a very appreciable extent. Tricks are even taught to seals, lions and elephants, and finally habits useful to man are learned by horse and dog. Thus man has appropriated to his own use the surplus energy developed in the higher animals and has profited thereby immensely.

But the stage of advance now under discussion is that of man's immediate precursors when they, too, had merely learned to profit by past experience through the method of trial and error and elimination of unsuccessful activities.

At this point doubtless the objection will be made that other functions affecting surplus had by this time appeared in man's precursors. It will be held that imitation, at least, was present far down the scale. Certainly it must be granted that any tendency of an organism *A* to imitate a useful innovation of a similar organism *B* would, in most instances, increase the surplus possessed by organism *A*. A flock of birds may take flight if a single bird flies away in alarm. This may be an advantage to every member of the flock. It is necessary, however, to distinguish sharply at least two kinds of imitation. Instinctive imitation, of which the case of the birds which fly when one of the flock takes wing may be taken as an instance, occurs when the sight or sound of one animal's performing a certain act operates as a direct stimulus to the performance of a similar act by another animal whose organization is such as naturally to lead to that act by reflex response whenever the appropriate stimulus is given. The model-act releases the trigger, the organism does the rest by reflex action in accordance with inherited functions. The second type of imitation occurs only when the model-act suggests to the observer the feeling of pleasure or the idea of utility that would result if he repeated the act for himself. The process involved in the first type appears to be no different from those which occur when an animal responds to any stimulus whatsoever. The function is reflex in accordance with the inherited structural organization

of the animal, but becomes modified by the trial and error method.[1] The functioning involved in the second type is radically different from that of the first. It implies the awakening of the impulse to repeat the model-act because of a more or less vivid recognition of its consequences. As Thorndike states it:

> One sees the following sequence: "*A* turning a faucet, *A* getting a drink." If one can free this association from its narrow confinement to *A* so as to get from it the association "impulse to turn faucet, *me* getting a drink," one will surely, if thirsty, turn the faucet, though he had never done so before.[2]

When the second type of imitation, voluntary imitation, appears there is necessarily a tremendous increase in surplus for all social animals possessing it. Thereafter any discovery made by one animal of a group may be transferred by a psychological process to all other animals in the group irrespective of whether they have been accustomed to perform that particular sequence of acts instinctively or not.

A most significant discovery has been made within the past fifteen years in the attempt to ascertain how far down the phylogenetic scale this power of voluntary imitation may be found. This discovery is that man alone possesses it to any considerable degree. Thorndike experimenting with chickens, cats and dogs found no evidence whatever of this type. Even his results with monkeys were, on the whole, negative. Small's rats showed no ability to profit by each other's experience in this way. According to Yerkes this type of imitation plays no considerable rôle in the learning processes of the dancing mouse. Hobhouse, to be sure, holds that cats, dogs, elephants and monkeys were aided in their learning if he "showed" them how to do a thing. Whether this was voluntary imitation, however, or whether the animals were merely aided in focusing their attention on the important object and thus received assistance by lessening the number of trials and errors, is a difficult question to answer. The past experience of the animals, moreover, was not always fully known in these experiments. Kinnaman's monkeys gave more positive results but, as Washburn says, we can not be sure that Kinnaman's monkeys really had an idea of the proper action suggested to them by seeing their companions perform it; the case might have been one of instinctive imitation, taking here a form more elaborate than was seen in cats and dogs because more compli-

[1] "An animal may perform an act the first time because, through inherited nervous connections, the sight of another animal's performing it acts as a stimulus. But it will continue to perform the act, in the absence of any copy to imitate, only if the act is itself an instinctive one, like drinking in birds, or becomes permanent by reason of its consequences, just as would be the case if its first performance had been accidental rather than imitative. As a matter of fact instinctive imitation seems usually to be concerned with actions themselves instinctive." Washburn, "Animal Mind," p. 238.

[2] "Animal Intelligence," p. 50.

cated movements are natural to the monkey than to the lower mammals. Berry also maintains that his experiments "have shown that voluntary imitation of a certain type does exist in white rats" and that "while this imitation is not of as high a degree as that discovered by Kinnaman in his experiments with monkeys, it is not different in kind." He thinks, also, that "a similar type of imitation exists in cats," that "cats to some extent imitate human beings" and that "cats do not instinctively kill and eat mice, but do so by imitation." He holds, however, that "instinctive imitation in cats is more important than students of animal behavior have supposed." Cole (L. W.) thinks he found evidence of voluntary imitation in the raccoon. These results, however, are open to the same objection as that raised against Hobhouse, namely, that the experiments may not have been sufficiently "controlled." In some laboratories efforts to prove the presence of voluntary imitation in the lower animals have been discontinued because of the discouraging uniformity with which negative results have been reached. No one seems to have found indisputable evidence. It is worth noting, however, that the most positive results seem to have been obtained with monkeys. What the experiments have shown unequivocally is that the animals tested learned almost exclusively by a gradual dropping off of unnecessary movements. Upon the nature of this process psychology has thus far thrown little light. Jennings says that the disturbance set up in the organism by the stimulus, by hunger or confinement, not finding an outlet by one path of discharge, seeks others in succession until one is found which relieves the disturbed condition. After repetition the change which leads to relief is reached more directly as "a result of the law of the readier resolution of physiological states after repetition." This "law" is, however, merely a statement of the fact.

It is doubtless true that intermediate stages are present between instinctive and voluntary imitation. Nevertheless, unless the work of expert observers of animal behavior during the past fifteen years is to be overthrown, the assertion may be made that man alone has developed voluntary imitation to any very important degree.

The significance of the advance to the voluntary imitation stage in development is second to none in the whole evolution of organic life for by its attainment human life, as we know it, now became possible.

It has been customary to recognize a more or less definite boundary between man and his precursors based on the development of speech by man. If, as a matter of fact, there is any value in attempting to define the boundary by a single activity, voluntary imitation may be suggested, on the objective side, at least, as of more importance than speech or language. Both voluntary imitation and speech appear to require either conceptual thought or something closely akin to it. Both may thus be taken as objective indices of the existence of that power of abstraction

which the psychologist and ethnologist hold to be a distinctly human trait. Both could have developed only as the power of conceptual thinking advanced. But speech seems to imply the existence of voluntary imitation, whereas the contrary is not necessarily true. The association of a particular sound or even gesture with a particular thing or act is not the only element in speech. There must be the *same* association in the minds of two or more individuals. The simplest way to account for such similarity of association is by the process of voluntary imitation. Doubtless inarticulate cries became signals arousing alertness to stimulation of various sorts long before voluntary imitation had become well-developed. Instinctive imitation had doubtless also created similar cries under similar circumstances, and nothing more perhaps was needed, in some instances, than the recognition on the part of one of two individuals that both used the same cry under the same circumstances, to produce the communication of an idea. The moment, however, an individual desired to make use of this recognition for the purpose of communicating an idea, he must have used the signal-sound as a model, knowing it to be the sound which the other individual associated with the idea he wished to convey. This purposive repetition of the model-sound involved voluntary imitation whether the model was the idea of another individual's cry or that of his own. It is evident, however, that soon after voluntary imitation appeared speech must have begun to arise. But many advances other than speech must have occurred as soon as voluntary imitation appeared. Long before language could have developed to any great extent man must have begun purposively to imitate things other than cries and gestures. The unskilful hunter must have learned new methods from the skilful. The man who discovered that a club was more effective than a fist soon had many followers making use of his invention. In short, voluntary imitation presently entered into every phase of life wherein it became possible to hand down by a psychological process the pragmatically valuable results of the past experience of the race. As soon as voluntary imitation appeared, therefore, the basis was laid for the continuity of history. Speech accelerated development tremendously, but it may be surmised with a considerable degree of probability that voluntary imitation of useful activities was well advanced before man did much talking that "accomplished things."

Doubtless the development of whatever degree of conceptual thinking is required for voluntary imitation was a long and gradual process. A prior stage in which thought was purely in recepts, to use Romanes' term, must have existed for ages. There may prove to have been other prior advances of an importance equal to that of voluntary imitation, the exact nature of which the observer of animal behavior may yet discover, but whatever may be in store in this field, it is certain that

the arrival of voluntary imitation marks the beginning of continuity in human history. Thereafter custom and tradition were possible.

The effect on surplus of the arrival of voluntary imitation is, however, the subject to which the preceding discussion has been merely a preliminary. For the effect on surplus was sufficient to free man to a considerable extent from the domination of purely biological processes and to make progress thereafter, as Professor Ward is continually reminding us, essentially a psychological process. The capital fact is this: whenever, after voluntary imitation appeared, a new discovery or invention was made, that discovery or invention rapidly became the property of the entire group. To whatever extent the relative amount of energy expended for survival was lessened for one individual it was lessened for all. Whatever addition was made to the surplus energy of the discoverer was likewise made to the surplus of all members of the group. Thus the inventors of bow and arrow, of canoe and hoe, immeasurably increased the surplus of society at large. So, from this time forth society increased its wealth, added to the bodily surplus of its members those economic goods which could be easily converted into bodily surplus, developed extra-somatic surplus as well as somatic surplus.

At this point a Malthusian might object that during all the early history of man population tended to increase rapidly enough to keep the surplus of every individual low. Even if this were so, it is nevertheless true that every gain increased the total energy available. A greater population in itself meant a greater total surplus, for, at times, the struggle for existence was suddenly alleviated and at such times the more individuals there were the greater was the sum of human energy freed from the effort to merely maintain existence. Such periods of rapid progress must have occurred many times in history. Every migration into a more favorable habitat, every invention and discovery, has tended to permit the size of human groups to increase and usually has tended to increase longevity as well. The use of fire, the invention of tools, the beginning of agriculture, the domestication of animals, the discovery of means of navigation, all these things increased the surplus at divers times and in divers places. How tremendous was the increase in social surplus gained by the combination of invention and voluntary imitation in the early periods of man's progress is indicated by a comparison of the differences between paleolithic and neolithic culture. From the earlier period rough stone implements of the chase, arrow points and what may have been spear points, but no hatchets, are found. Plentiful indication of cave-life, but, in general, no evidence of cultivation, of pottery or use of fire has been unearthed. Domesticated animals were probably non-existent. Social life was doubtless extremely simple.

Contrast the neolithic culture. When that stage first was reached

man had added agriculture to hunting, used hatchets and smooth stone implements, made pottery and baskets, erected houses, controlled fire, had domesticated sheep and cattle, had begun spinning and weaving, lived in stable villages and had a comparatively complex social life. Life was infinitely more worth living in the neolithic period. Compared with the ages that passed before the anatomical and mental characteristics peculiar to man appeared, this increase in well-being—in surplus energy—between the paleolithic and neolithic periods took place with tremendous rapidity. The actual time must be reckoned in tens, perhaps hundreds, of centuries, but, in comparison with the period that had been required for the production of voluntary imitation by biological processes, the interval between the paleolithic and neolithic periods was but a day. Voluntary imitation and invention had increased the rate of progress many-fold.

To review the successive gains through invention, discovery and imitation during the historic period would not strengthen the argument. In these latter days, we know, the power of the western world has far outstripped even the greatest population increase the planet has ever seen and at the same time has raised the plane of living far above the average of even a century ago. We may turn, therefore, to the inferences of sociological importance which may be drawn from the foregoing facts. Not merely do they show, as has been indicated, that the appearance of voluntary imitation marks the beginning of distinctly human history, but they also provide a definite reason why biological deterioration is not greatly to be feared at present and why the sociologist who bases his explanation of society more upon psychology than biology, is right. For, if it is admitted that the time required for the development of man's somatic surplus through the operation of biological processes upon his structural and mental characteristics was indefinitely longer than the period required for creation of all the extra-somatic surplus accumulated since voluntary imitation appeared, then the conclusion is apparently inevitable that, unless for some reason the biological processes that make for degeneration are much more rapid in their action than were the evolutionary processes that produced the ability to imitate voluntarily, human society is able to increase its total surplus even if somatic-surplus remains constant or even declines to some extent. To put it briefly, extra-somatic increase will more than offset a threatened somatic deficit unless the powers of invention and voluntary imitation are impaired. Somewhat differently stated, up to the limit where biological processes seriously affect them, invention and voluntary imitation will increase the sum total of social surplus faster than biological processes will impair that surplus. That this limit is likely to be reached quickly is absurd. To reach it quickly we should have to breed from the most inferior stocks alone. The burden

of proof lies definitely upon those who fear disastrous consequences from biological degeneration to-day to show that those degenerative processes are proceeding so rapidly as soon to threaten the rate of increase of somatic and extra-somatic surplus energy combined. To prove their case they must show that the decrease in somatic surplus, if it exists, will offset the increase in extra-somatic surplus produced by invention and imitation. There are two and apparently only two possible ways of proving such a thesis. The first is to show that somatic surplus is likely to decrease much more rapidly than it has in the past. The second is to show that the increase in extra-somatic surplus, which has registered itself in a continuous elevation of the plane of living since voluntary imitation began, is to turn itself into a deficit.

Now it is self-evident that, however much variation there may be among men with respect to individual traits, the vast mass of humanity is endowed at birth with potentialities that render an elementary education of advantage. Though there are few men of genius, there are also few individuals unable to exercise voluntary imitation. Even if the devolutionary process feared by the eugenic school were to take place with some degree of rapidity, it would take many generations of "reversed selection" to undo the work of the indefinitely longer period of evolution which was required to produce man's present equipment of innate abilities. Genealogical records show no disappearance of family names rapid enough to indicate that even under the most unfavorable circumstances much change could be effected by selection in less than several centuries. If this be true, sociologists, however much they may approve the extension of particular eugenic methods that have demonstrated their efficiency, may wait patiently, if necessary several centuries, for the psychologist and biologist to produce exact results respecting the variation and heredity of psychic traits before they admit great danger from biological degeneration.

It is undoubtedly true that the increased surplus has permitted society to care for many of its unfortunates who in more strenuous times would have been left to perish. But with all the assistance that has been given for centuries the proportion of dependents does not seem to have done more than retard the increase of social surplus in much the same way that the surplus has been affected by modern expenditures for luxuries, whether these have taken the form of individual extravagance or national waste in accoutrements of war.

At least such seems to be the case in the western world, where, thanks to free land, a century of invention and a lowered birth rate, the economic problem, we are told, has transformed itself from one of production to one of distribution. Whether the eastern world is likely to attain an equal surplus is perhaps to be the most interesting question of the coming century. The western world is teaching the east the

modern methods of production. It remains to be seen whether the east will use this increased power over nature, gained by voluntary imitation, for the development of a higher plane of living or will merely increase the total population of the Orient on the present plane of misery. The argument from the past is never wholly safe but so far as that argument applies to the present problem it seems to indicate that, as man continues to profit by the method of proving all things and holding fast to that which is good, he will learn in the east as well as in the west that progress will occur by the discovery and rational imitation of those processes which, to use terms employed by Mr. Herbert Spencer, develop individuation with the least necessary expenditure for genesis, or, in terms of this essay, will produce the greatest surplus with the minimum expenditure for survival. When that lesson has been learned man may turn more of his energies from the effort to live, to the endeavor to live well.

RISING PRICES AND THE PUBLIC

By Professor JOHN BAUER

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THE increasing cost of living, or more properly rising prices, has been the subject of much recent discussion. The *causes* have been explained and reexplained; everybody knows about increased gold production, also about the trusts, the tariff, labor unions, etc., in their joint and several relations to the subject. But the *evils,* especially in their broad social relations, have been less definitely analyzed and stated. It is true that the ordinary consumer has paid more money month by month to the grocer, the landlord and others, and that he is complaining rather vigorously about it. Neverthless, for the most part he has imagined and has been taught to believe that the higher prices have meant public prosperity—*i. e.,* larger profits and more business.

Rising prices usually do mean more profits, but not necessarily more real business. The profits usually go to the grocer, the landlord and others, while the ordinary consumer pays them and is so much the poorer. Unluckily the losses and gains, both unwarranted and unearned, have not stopped simply with making the consumers poorer and the dealers richer. They have not been individual matters. The broad effects have permeated our entire social structure, operating through devious ways, working mischief upon the public.

The evils complained of are not due to high, but to rising prices. Either high or low prices in themselves signify nothing, if the incomes are adjusted accordingly. If the prices are simply high, not rising, then wages, salaries and other money incomes will be correspondingly high; all exchanges will simply be based upon a high level. Likewise, if prices are low throughout, not falling, then again wages and other money incomes will be correspondingly low and exchanges will be carried on at a low level. It is the shifting from low to high, or from high to low, that produces mischief. Various mal-adjustments in economic relations follow. All prices and values do not change at the same rate. The normal forces of supply and demand are upset. Some incomes are unduly diminished while others are correspondingly inflated. There are undue losses and undue gains; both are unearned and both are detrimental to the public welfare.

In 1910 general prices in the United States were 47 per cent.

higher than the low level in 1897. This is according to the figures of the United States Bureau of Labor. According to Bradstreets's the increase was 52 per cent. For our present purposes let us take roughly 50 per cent. Now observe the increase in the different classes of commodities: farm products advanced 110 per cent.; lumber and building materials 69 per cent.; food 54 per cent.; metals and implements 48 per cent.; clothing, fuel and lighting 35 per cent.; drugs and chemicals 33 per cent.; house furnishings 24 per cent.; miscellaneous items 45 per cent.[1]

We should note that the articles entering into the food and shelter of the ordinary consumer have advanced most, also that these items, *i. e.*, food and shelter, require about two thirds of the ordinary family expenditures—among the working classes as much as three fourths. Therefore, allowing for this fact, our estimate of 50 per cent. is clearly a conservative statement of the higher prices paid by the consumer now compared with 1897.

Our proposition is that as a result of this increase some classes of incomes have been unduly diminished and others correspondingly inflated, all to the detriment of the public. The following points should make this proposition clear.

1. Wages have lagged behind in the upward movement of exchange values and have brought consequent losses to the working classes. Money wages have advanced only about 40 per cent. compared with 50 per cent. in prices. Consequently, while the ordinary laborer receives now more dollars than in 1897, he receives considerably less purchasing power, less comforts for himself and his family, less real income.

But, why this loss? Merely because changing conditions in supply and demand reveal themselves more readily in prices than in wages. In a shifting exchange level, unless special forces intervene, wages move behind prices, advancing and likewise receding more slowly. Consequently, in an upward swing the wage-earning classes lose in real income, while in a downward swing they gain correspondingly. The explanation is that wages are controlled more by custom and social standards than are prices. When real conditions of supply and demand change, prices usually respond readily enough, still not without the retarding influence of custom. But with wages, custom is a heavy break upon change, allowing proper readjustment only after a considerable period.

The writer believes that under normal conditions of exchange real wages should have advanced in recent years. Disregard price: look at

[1] These calculations are based upon the index numbers of prices published in the Bulletin of the United States Bureau of Labor, March, 1911.

the improvements in all lines of industry, and at the actual increase in the production of commodities! Is there any doubt of increased productivity? If not, then under normal economic law, part of the increase should have gone as an addition to the real wages of labor. If this assumption is correct, the working classes should have gained in comfort and well-being, while as a matter of fact they have lost. Do you wonder at the discontent and unrest in labor circles?

2. While prices have advanced faster than wages, all prices have not moved up at the same rate. As stated in another connection, farm products, building materials and food have led in the upward movement. Other things have advanced less rapidly, some have remained practically stationary, and a few have in fact declined. Not all industries then have benefited alike from the shifting exchange level; some have not gained at all, and a few have lost.

However—and here is the important point—all laborers, whatever the industry in which they are employed, have been affected alike by the higher prices—all pay 50 per cent. more for food and rent than in 1897. Consequently, there is a pressure for increased wages in all industries, whether they have gained from the changing prices or not. Where they have gained, the desired increases may be granted readily enough, to avoid interruption of business. But where they have not gained, higher wages mean diminished profits or even losses. It is particularly in these industries where we find serious labor difficulties. Both employers and employees have lost or are threatened a loss in income. Neither side understands the position of the other and is unduly embittered as a consequence. The shifting price standards have simply deprived these industries of their former relative prosperity, and until normal readjustment takes place, the losses can not be avoided. The question is who shall bear them—employer or employee?

Fundamentally, this is perhaps the trouble in the many threatened railway strikes. Costs of railway operation have steadily advanced, while rates and fares have remained practically stationary. While this point can not be definitely determined, it seems certain that the railroads have not shared in such undue gains as have fallen to other industries through the shifting of prices. Yet they face the same pressure for higher wages; the demands are supported not only by powerful labor organizations, but by the more powerful public opinion. Until proper readjustment takes place, we must expect discontent and mischievous disputes.

Likewise this was probably the real trouble in the recent Lawrence, Massachusetts, strike. The textile mills, especially those of New Eng-

land, have apparently not shared in the unearned profits which rising prices have brought to other industries. From the workingmen's standpoint, the need for advances in wages is obvious enough. But from the employers' standpoint such advances will probably mean marked reduction in profits.

The public press has pointed to the large profits of the mills and to the fact that the stock of some of the companies is selling at ten times the par value. But these facts signify little; profits were large fifteen years ago and the value of the stock has been high accordingly. The point is, the mills have not made such additional gains in recent years as have other industries; they have been pressed by the increasing cost of production; and have relatively fallen behind in prosperity. Advances in wages will probably mean cut profits and consequently lower stock values. The writer is not defending the mill owners nor yet the operatives; he is merely pointing out a serious mal-adjustment, for which neither side is fundamentally responsible, but from which both are suffering.

3. As in the case of prices, so the wages of different classes of workmen have not advanced proportionally. Those affected pretty directly by the changed conditions of supply and demand advanced first, and those affected remotely, last. Then, if we distinguish broadly between wages and salaries, we find that the latter particularly have responded but little to the shifting exchange level.

Salaries even more than wages are controlled by custom and rigid social standards. Moreover, when they change they do so by jumps, not gradually, as wages. Thus the salary of a clerk is $800 a year, or $1,000, $1,200 or $1,500; an intermediate sum is unlikely; the passage from one to the other is difficult and is painfully resisted by the employer.

So, while wages have advanced gradually about 40 per cent.—not enough to counterbalance the rise in prices—salaries have remained almost unchanged. Again, however, conditions have varied a great deal between different classes; in few cases there have been large advances, in others moderate ones, but in the majority practically none at all. Unfortunately we lack definite statistical data as to salary standards. But, if we can rely upon observation by students of social affairs, we are warranted in holding to the general conclusion stated.

Salaries, then, perhaps more than any other class of incomes have lost through rising prices. In fact, only recently have they clearly begun to move upward. Eventually when a final high level of exchange has been reached, especially if a downward swing sets in, equitable adjustments will undoubtedly be reestablished, or gradually persons

of the needed ability will not enter the various important positions. In the meanwhile, however, the masses of salaried men, all more or less especially trained experts, can not escape the unwarranted losses. They can not leave their employment for lack of training to enter another. They have to submit to losses that are unearned, when for the most part they have deserved better of the public.

4. Persons and institutions with their capital invested in loans have found themselves gradually worse off as prices have advanced. This proposition is particularly true of long-time loans, made either before or early in the upward swing of prices. Obviously both principal and interest were fixed once for all in the loan contract. Consequently, as prices have gone up, the lender received less and less purchasing power in the form of interest, and at maturity of the loan he had also the principal returned to him in depreciated dollars. Prices having advanced on the average about three per cent. a year, he should properly have received also three per cent. a year additional interest money, and he should get back now, not the number of dollars lent, but 50 per cent. more, to offset the decline in the purchasing power of the dollar.

Specifically, if in 1897 a person lent $1,000 for fifteen years at four per cent. interest, he should have received $41.20 interest for the first year, $42.45 the second, $43.72 the third, and so an increase of about three per cent. a year through the period; likewise now, in getting back the principal, he should receive not $1,000, but $1,500. Obviously he has lost, and the borrower has made the corresponding gain. The point is, loss and gain were unforeseen and were not contemplated in the loan contract.

We have here a large class of losers, including owners of government, municipal, railway and other bonds, mortgage notes, fixed annuities, and similar forms of investments. Among persons, the class includes widows and orphans, people with savings for old age, professional men seeking safe places for their surplus income, and business men retired from active enterprise. Among institutions, there are endowed hospitals, charitable organizations, colleges and universities. In general, the class includes only cautious investors, who, so far as possible, seek to eliminate risk from their incomes. Their caution has been rewarded by losses. A virtue which is not too plentiful among investing classes has received rather discouraging setbacks.

For loans made in recent years, especially for short time periods, there has been some compensation for the loss of purchasing power. Since 1900 interest rates have averaged from one to two per cent. higher than normal. This extra rate has in part, but not altogether, offset the average annual rise in prices. The interest rate is now five

or six per cent. on safe loans, compared with about four per cent. fifteen years ago. On $1,000 the lender now receives $50 or $60 interest, compared with $40 fifteen years ago. The higher interest rate has resulted as part adjustment for the advancing prices or the decrease in the value of money. But again, just as in the case of wages, the adjustment has not gone far enough, so that there has been a net loss to the lender.

In general, as a summary of the points that have been made, wage earners, salaried employees and cautious investors have lost, while with few exceptions owners of industry and the more speculative investors have gained. The first class includes all contractual incomes, like wages, salaries and interest, which are fixed by agreement; while the second class includes principally non-contractual incomes, like dividends on stocks, profits on real estate, factories, stores of goods, etc.—incomes not fixed by agreement, but depending upon the success of the business.

Some one remarks that the losses and gains have no particular social significance; some classes merely have lost while others have gained in the scramble for income. The answer is, in part, that whenever undue losses are brought upon large classes in society, resulting in hardships and discontent, the evils communicate themselves even to the classes not so directly affected. No class lives unto itself; discontent in one will work through the whole group. However, there are also evils which are distinctly social, affecting society as such, distinct from individual classes. These evils may be outlined briefly as follows:

1. The advancing prices have introduced an extraordinary risk element into business. Undue gains have been made by some classes and undue losses by others. Gains and losses have been fortuitous; they have not resulted from mere careful or careless management; they could not be definitely foreseen, and therefore planned for or avoided. Who can tell whether prices in general will rise next year? Or the price of a particular commodity? Or wages? Or salaries? For the individual business, or person, is not a particular advance wholly an accidental matter? If with one class rising prices mean greater profits, then with another class do they not mean greater costs, which, too, are uncertain?

So far as possible, business men and people in general seek to eliminate risk from their daily relations, and they have invented insurance for this purpose. But you can not insure against rising prices, for they do not move by any definitely known law of averages. Economics can tell you why prices change, but it has not the data upon which to predict with reasonable accuracy any particular change.

Here is a risk which the business man can not escape; neither can any one else; it affects us all, and, for the most part, in an evil manner.

2. The rising prices have fostered speculation in all lines of industry and investment. Large profits have been made in recent years only by those who have taken large risks, often foolhardy ones. Cautious investors—inelegantly but clearly expressed—have been stung, while the owners of corporation stock, real estate and other speculative properties have made in many cases scandalous profits. Consequently, more and more people have turned to the riskier investments. The additional demand for them then forced their prices still higher, which in turn furnished an incentive for further speculation. Thus in many instances stocks have climbed to heights which, relative to other values, simply can not be permanently maintained. Likewise, in nearly every city of importance in the United States real estate values, particularly land, have reached such ridiculous figures compared with other prices that they simply must collapse (beholding their own monstrosity).

This means a financial panic. Credit operations in recent years have been based too largely upon uncertain and inflated money values. Some time in the reasonably near future, during a period of rather general liquidation, the paper profits of our speculative classes will show what they really are—phantoms which dissolve into nothingness at the touch of business reality.

The panic of 1907 was perhaps principally due to the speculation of the previous period of rising prices. However, except for a temporary halt after the panic, the movement upward has continued unabated. Moreover, it probably will continue many years to come; at least the fundamental cause of the movement—excessive gold production—gives no promise of lessening its operation for a long time. In the meanwhile, before final adjustments are made, before a final high level of prices is reached, or before a downward swing is started, the writer fears that we are doomed to several panics, probably severe ones, bringing disorganization of values, collapse of business, unemployment and general hard times.

Apart from panics, look at the social waste of speculation! For example, the ordinary dabbler on the stock market has no real interest in the corporation whose stocks and bonds he is buying, and he does not create any substantial values. Nor does he buy because he knows that the stock is selling for less than its intrinsic worth. He has a tip or a "hunch" that the price will go up, and he takes a chance at easy money. But win or lose, he neglects any sound business for which he is trained, and so wastes his time for the public.

Likewise, the multitudes of real estate dealers the country over are not *bona-fide* real estate men, studying the needs of their community,

improving run-down properties, planning and laying out new residence sections where demand is likely to go, and in other ways anticipating the needs of the people. On the contrary, they are merely guessing at changing values, holding property, not to improve it, not to supply any need which they have foreseen or created, but merely hoping for higher prices and handsome profits. Undoubtedly many persons have reaped and many others will reap large rewards by this process; also many have lost and many others will lose by it. But this is the important point: all are neglecting any real industry, so that for the public at large there is a scandalous waste of energy, which should be turned to useful purposes.

3. Finally, rising prices have fostered extravagance. Some one has facetiously remarked that we are suffering less from the high cost of living than from the cost of high living. This is in a large measure true. The point here is that the high living has resulted in a considerable degree from the increasing cost of living.

The ordinary consumer feels clearly enough the greater cost of practically everything he buys compared with fifteen years ago; but he also receives a greater money income, whether in the form of profits, interest, wages or even salaries. On the one hand, he realizes perfectly that money is not worth so much as in 1897, for prices are higher; at the same time he has an ingrained feeling that the value of money never changes. He receives now more actual dollars and he feels almost correspondingly better off and spends according to more lavish standards. Further, after paying for food, rent and other necessaries, although the sums are large, he has now left a larger surplus than in 1897 to be used for other things. It is particularly the value of this surplus that he does not understand; it is only *apparently* larger, actually it is smaller. And it is particularly the spending of this chimerical sum that has led to extravagance.

We have to do here with a peculiar contradiction in feeling. In one sense people are perfectly aware that the value of the dollar has decreased, for prices are higher; but in another sense they have the ingrained notion that the value of the dollar is a fixed, absolute, unchanging thing. We may call this contradiction, the paradox of the sense of value. This paradox is common even among persons trained in the science of money. It has led many classes of people to adopt unwarranted scales of expenditure, especially in reference to amusements and various forms of display.

For an illustration, suppose that since 1897 prices have increased 50 per cent. and wages 40 per cent. Then a working man who received $600 a year in 1897 and spent $400 for food and rent, receives now $840, and spends $600 for food and rent. Naturally he feels better

off than in 1897: he receives now $2.80 a day instead of $2.00, and he has a surplus of $240 a year above food and rent instead of $200 as in 1897. Likewise a clerk or mechanic who in 1897 received $900 and spent $600 for food and rent, receives now $1,260 and spends $900 for these necessaries. He receives now $4.20 instead of $3.00 a day and has a surplus of $360 instead of $300. In spite of the higher prices this additional money makes him feel better off than before; consequently he has enlarged his ways of living according to his feelings, not according to his real income.

Merely to offset the price changes the workingman of our illustration, to be as well off as in 1897, should receive $3.00 a day instead of $2.80 which he actually gets, and he should have a surplus of $300 over necessaries instead of his actual $240. Likewise our clerk and mechanic should get $4.50 a day instead of his $4.20, and should have a surplus of $450 instead of his actual $360. In fact, both laborer and clerk have been losers and they have erroneously felt themselves gainers in income.

The same paradox appears with classes whose incomes have advanced proportionately with prices or have advanced faster. Everybody has the feeling of having more income than he actually has. The middle-class man who formerly saved $1,000 a year should now according to the same standards save $1,500 to offset the 50 per cent. increase in prices. Everybody to save as before should set aside annually 50 per cent. more dollars. Among social classes throughout, how large a proportion of people are doing this? If not, people are not saving as they think they are. The man who formerly carried $10,000 life insurance for the protection of his family, should now carry $15,000, merely to have his family protected as before. Any one who has not followed this ratio of increase is not protecting his family as he supposes. Further, merely not to be poorer a person with a capital of $100,000 should now have $150,000. Any one whose capital investment has augmented less than this ratio has obviously lost in real financial standing.

All along the line the diminishing dollar has played tricks on our sense of values, making us feel more prosperous than we are. As a consequence too many of the working classes have regularly indulged in Coney Island or in its miniature counterpart, in picture shows, swell clothes, etc. Too many of the middle classes have attempted automobiles, expensive summer vacations and trips abroad. Of the extravagance of the rich, there is no need to speak; it has been so glaring and senseless. Luxurious living is excellent if you can afford it. But insidiously we have been led into extravagances that we can not afford. Too many of us have been living on capital, erroneously thinking it income.

To be sure, the growth of extravagance can easily be exaggerated. It must be admitted that the rising prices have also the effect of leading to certain economies. Many families have undoubtedly made proper adjustments in their expenses and savings all the time as prices have been moving upward. Also, even in the ordinary household, the resentment against constantly climbing charges has unquestionably resulted in many more frugal uses and cheaper food substitutions. For example, now with butter at 40 cents a pound and eggs at 35 cents a dozen, the various cake and other pastry recipes call for little more than half of these ingredients compared with fifteen years ago, when they were bought for less than half their present prices. Now, when desirable cuts of meat cost from 20 to 30 cents or more a pound, people are turning more and more to cereal and vegetable foods—probably with physiological as well as financial advantage. Other similar savings might easily be cited.

But, while such economies have undoubtedly been made, often even painful ones, the paradox which we have been discussing has not been necessarily avoided. Too often these economies are counterbalanced by extravagances in other directions. What is saved on butter and eggs and meat is more than offset by moving pictures, nifty clothes, an automobile, or what not. Probably very few people have completely escaped the lure of living higher than their real income affords. How impossible, or at least how hard, it is even for the most prudent to know, and all the time to *live* as if knowing, that the dollar is not always a dollar!

Speculation and extravagance are closely related manias. Their worst feature is that they fasten themselves rather firmly upon the people. We can study their effects and their causes, but we do not know very well how to remove them. They will abide with us probably a long time after prices have reached their high point or have begun to swing downward, or after other causes have subsided. Customs and social standards change slowly.

In conclusion, the writer would admit that many causes have probably contributed to the growth of speculation and extravagance in recent years. He does not believe that the rising prices have been the sole cause. But he is convinced that in the ways pointed out they have been a powerful factor in fostering these social evils.

As a practical matter for the public at large, everything possible should be done to prevent any considerable change in the price level—either upward or downward. So far as possible, the dollar should always be a dollar; its value should be a fixed, absolute, unchanging thing. If not, the evils are bound to appear as they have been stated.

THE FUNCTION OF THE AMERICAN COLLEGE

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ALONG with the movement toward vocationalism in the lower schools, there is at the present time apparent an equally powerful and not wholly unrelated trend in the higher toward intellectual specialization. Any one who is acquainted with the situation knows that in so far as the college and university teacher has to-day any distinct notion at all of what he is about, it is likely to be in the majority of cases in terms of an exaltation of scientific scholarship. The business which he conceives he is there to forward is to produce thinkers and investigators of the specialized and technical sort that he is familiar with among his colleagues and in his scientific associations. And the commonest justification of this is apt to be in the form of a claim that the task of the schools is to produce leaders. In consequence the teacher gets into a habit of considerable asperity toward the average member of his classes in whom he sees no special promise of distinction. His dealing with them becomes perfunctory, and all his enthusiasm he reserves for the few who can be expected to go farther along the paths of academic glory. The special ideal of the university is apt to overshadow the entire scheme of higher education.

One result of this tendency is the anomalous position which the college is at the present day coming to occupy in the American educational scheme. To one who is not content to see an institution simply in existence, and doing work which has something to be said in its favor, but who wants to adjust it to a principle, it is growing a very puzzling matter to state with any approach to precision the function of this typically American contribution to the forms of educational expression. The original function of the college was professional preparation, which at the same time came pretty close to a training for social leadership as well, since the professions to which it led, including in particular the profession of divinity, were looked to more consciously than at the present day to provide the material for leadership in ideas. But if one were to try to justify theoretically the college now on the same ground, two facts at least would need to be recognized. In the first place the college does not actually at present, except in the form of a pious aspiration, base itself upon intellectual distinction, or aim at developing peculiar capacities for special kinds of intellectual service. And we can the more readily admit this, inasmuch as in the university we have a new type of institution which does have just this aim. Accordingly,

since the discovery and promoting of peculiar intellectual excellence is perhaps the most obvious statement of the end of higher education, we find a strong disposition of late among those who care for the theory of education, and like logical neatness, to look forward to the day when the college as an institution shall have been shorn of its present importance. The tendency is rather strongly in favor of cutting off the college proper at both ends—assigning the last two years to the university as a preparation for technical professional work, and either adding the first two to the high school, or leaving it a torso which would seem bound to approximate to the type of the academy.

A defense of the college as a peculiar institution will need to recognize first, I think, two sets of distinctions. One is the distinction between professional or scientific efficiency in specialized tasks, and an intellectual leadership in the sense in which this affects directly the general life and ideals of the nation. Now that the university is the instrument for developing the first or specialized intellectual capacity, of course goes without saying. But that this is identical with the second sort of eminence and leadership, pertinent to the political problems of democracy, is not in the least self-evident. At present I simply call attention to the distinction, and to the fact that if we think fit to introduce at all the social need into the argument for education, we should not identify this with the sort of scientific leadership which the university does confessedly aim to develop.

But now my argument for the college would be, that while the purpose which gives it a right to continued existence alongside the university is distinctly its social rather than its professional, or, in the narrow sense, scholarship, value, it is not primarily social *leadership* that it should aim directly to provide for. The second distinction is that between the comparatively small body of notably able men who will always have to direct the course of society and interpret for it its ideals, and the larger body of enlightened opinion which is needed to direct this in turn and keep it from substituting a caste ideal for the people's will. And it is in the creation of this last that I should find the special purpose of the college to lie.

That the tendency of the university ideal to emphasize too exclusively the importance of special ability constitutes a possible social danger is, I believe, coming to be felt. An emphasis on ability turns almost inevitably under modern educational conditions in the direction of specialized ability. The exaltation of the university ideal is therefore coming to mean a sacrifice of breadth and perspective to the demands of technical proficiency. This may mean, if it goes farther, that our most highly educated classes no longer will possess the qualifications that are needed for sound human political judgment in a democracy. A catholicity of interest and sympathy is required here rather than

scientific habits of mind applied to some narrow field; without it, there is not the slightest guarantee that the trained man will be a better citizen, though he may be a better physician or lawyer or engineer, than the comparatively uneducated artisan. Indeed the artisan, because of his wider human contact, may easily have the advantage. That the specialist is in constant danger, through over-estimating the sufficiency of the scientific intelligence, of losing his sense of democratic proportion and so becoming a member of a narrow caste, is shown in the actual tendency in academic circles. On the whole, the university reveals a tone of aristocracy which is constantly passing over into snobbishness. It inclines to the principle of the closed shop, where a small group of men with peculiar interests look down with more or less imperfectly concealed disdain upon the uninitiated. If one is convinced that in this direction social salvation lies, very well. But if he still inclines to the older ideals of democracy, it will seem to him a risk. And the nearest salvation lies in the creation of a more massive body of enlightened good judgment, which shall bridge the chasm between ignorance and special ability, and obviate the excuse which the pretentious claims of the few profess to find in the incapacity of the masses.

Now in the American college we have an institution which seems admirably fitted to perform just this service if it sets about it in the right way. So regarded, its function would be not to cater to the specially gifted class, but to provide a means by which the great mass of ordinarily intelligent men and women can, if they have the will, absorb a measure of disinterested culture, and so broaden their vision of men and things that, leading the lives of ordinary citizens, they may furnish a saner, less hide-bound, more dependable quality of citizenship, such as is needed to temper the ambitions and the self-sufficiency of the powerful and able few, and to afford a medium through which more humane and gracious political manners may leaven the majority. It seems very questionable whether the extension of the high school could accomplish just this task, certainly as the high school exists to-day. For the earlier work of the high school necessarily presupposes a lack of maturity which determines its methods as not the same that the college requires; and constituted as the pedagogue is and probably always will be, it is too much to expect that a teacher will be able to adapt himself successfully to two quite different tasks.

I look, therefore, to see the college more and more, if it recognizes its responsibility to democracy, make its main end not scholarship in the technical sense, but breadth, poise, vision. Furthermore, it must aim to extend its opportunities to just as many as possible, instead of serving as a selective agency to sift out those of special promise in things of the mind. I do not mean by this that to every one alike a college course is beneficial. Doubtless there are many now in college who would

be wiser to turn to some more immediately practical and active work. But the situation which makes such a judgment common among college instructors is not, I am persuaded, just what it is frequently interpreted to be; it is not, that is, proof of a hard and fast demarkation between the intellectually unfit and the elect, based on distinctions of natural equipment. There are at least two other reasons for the sort of difference between students which makes it so difficult oftentimes to adjust teaching to the material it has to work upon. The first is the lack of preparation in the foundations of intellectual culture which the student brings to the college—particularly in the power of good observation, accurate thinking and clear English expression. A large share of the difficulties of the college teacher consists in overcoming the handicap with which the student starts. But theoretically this would not exist if our lower schools were what they should be. Not, of course, that it is equally easy to teach even these to all minds. But it is possible to do it for the great majority. And for the lower schools, at any rate, to fall back on the plea that they are there simply to provide the materials of knowledge, while disclaiming responsibility for the mass of those who need special encouragement and attention, is to confess the bankruptcy of our educational system.

The second great drawback to a proper level of attainment in the mass of college students is the lack of interest and ambition. But this again is a largely improvable situation. The simplest way to meet it would be undoubtedly to devise plans for the quick elimination of students who show that they have no real desire for a college training. In this I can see no injustice; it only would be well before putting it in operation, that educators should search their own hearts to make sure to what extent the fault lies in themselves. The temptation is, again, to take too readily the stand that the business of the teacher is merely to set forth his educational wares, and leave it to the student to make what use of them he will. And if our aim were merely to develop special ability, as indeed it is in the university proper, there would be nothing to be said against this. If, however, we take the stand that education is not a matter merely for selected individuals, but has a duty to perform in leavening the mass, it becomes an important point of the teacher's duty to develop interest, as well as minister to it when it is already there. For a persistent intellectual interest is not a natural taste, but an artificial one. Natural interests furnish its conditions. But these are transient for the most part and easily discouraged; to turn them into permanent habits of mind needs all the technical skill and pedagogical enthusiasm that can be brought to bear. But when our school methods, lower and higher, are revised to this end, then a rigorous process of weeding out such portions of the student body as show no genuine purpose and effort, but treat instead their studies as incidental

to the ends of athletics, social functions or the pleasures of inertia, is not only justifiable but necessary for any worthy standard of educational work, and if acted on intelligently would go far toward getting rid of the greatest difficulties in the proper working of the college.

But with these drawbacks discounted, I do not believe there need be any great problem arising from the merely average, the naturally less gifted student, who comes to his work well prepared in fundamentals, and with enough of interest to lead him to exert his best powers. And it is to this class in particular that the college, if it is to have any reason for existing alongside the university, should, I believe, professedly aim to adjust itself, instead, as now, of accepting the situation as one that is forced upon it, while its heart is in the university ideal of making professional scholars and investigators. And the reason is, again, that the exceptional man in a democracy loses a great share of his social value unless there is a large public to which he can appeal, through reasoned judgment rather than emotional prepossessions—a public possessed of a maturer outlook than it is possible for the high school to insure. This is not to give countenance to the superstition that no one can be a sound philosopher and a good citizen without a college degree. And I am intending, too, to exclude a more debatable aspect of the matter which confronts us under present academic conditions. It undoubtedly is true that many men now in our colleges might well be advised that they are out of place; not, however, because such a training might not enhance for them the value of life and enlarge their own value as citizens, but because if they persist they are likely, owing to the common aristocratic conception of a college course which they share, simply to look upon it as a means of escape from the life work for which they are really fitted, in order to enter a more respectable line. It is this tendency to a resulting maladjustment, perhaps, which teachers have in mind when they deplore so frequently the ambition of certain students for a college career. But if, instead, they are setting up to say, on any large scale, that a man's mind is unimprovable, and that he is a fool to try to make of himself anything but the slow and stupid animal he is by nature, one can only attribute such a judgment to that other product of nature—an intellectual intolerance and superciliousness which should be educated out of the teacher, of all men, before he is fit for his job.

If this aim be accepted for the college, certain modifications of academic tradition might conceivably follow. It would suggest some change of attitude in the matter of conditions of entrance. The purpose would then be to encourage as many as possible to utilize the advantages which the college offers, whereas at present the chief concern seems to be to keep out the unworthy. Of course the justification for such entering tests, which are all the time becoming more rigid, is the

standard which the college is called upon to maintain. The motive is a good one, though one may suspect that intermixed with it one less defensible also plays a part. Interpreted by the professorial mind, it too often takes the form of an illiberal prejudice against admitting to the benefits of learning any one who has not gone through with a particular sort of officially recognized initiation, and thus complied with all the regulations of the guild. The need for some sifting out process is, however, very real, and it has seemed the easiest way to erect a strongly picketed fence, and take great pains to see that no objectionable person gets inside. This has advantages, but at least it is unfortunate that it seems to place the emphasis on exclusion rather than on the offering of opportunity—a result which will show itself in pretty nearly any college faculty, where a question of the stricter interpretation of entrance conditions can be counted on to arouse more enthusiasm than is ever called forth by the case of the ambitious and possibly quite capable student who can not meet the academic tests.

It is scarcely to be expected, perhaps, that the college will turn back from a policy so apparently settled. But it may at least be noted that there is an alternative program. The only condition that is really essential for permitting a student to take a given piece of work, is his ability to do it with profit, and without detriment to the proper workings of class-room efficiency. And to substitute for this the record of past attainment, often merely nominal, is not only to erect a fetich which may become obstructive, but it is largely to fail of the end in view; for every teacher knows that the possession of "credits" is almost no indication that a boy is ready to go on with a new task. If instead of making a test which precedes actual trial, the college were to make this trial itself the test, were to let every one have his chance who wished to take it, and then expeditiously and firmly exclude him so soon as it became apparent that he was a misfit, not waiting until the end of the year or of a term, but acting the moment there was no reasonable question, not only might the real end be attained much better than it now is attained, but it would be secured without danger of turning the college into a thing of mechanism and red tape, and without restricting the advantages of education beyond absolute necessity. The reason why this would not work can only be in terms of the instructor himself. If he will not take the responsibility of using his judgment, but will allow things to drag along without remedy, he will soon be in trouble. But whereas there are institutions doubtless in which it is advisable to discount as much as possible the defects of the human factor by machinery, education is emphatically not one of these; and the tendency to make it such is one of its greatest present dangers. As a matter of fact there seems nothing so far beyond the powers of the average man who is competent enough to deserve a job on a college

faculty, in the supposition that he should have enough judgment to sift out those who are not likely to profit by his work, and consequently should have the power to exclude them from his classes. If such a demand upon him were to compel a more direct personal relationship with his students, that would not be an unmixed evil. As a matter of fact, the trouble does not lie so much in the inherent difficulty of the task as in its lack of harmony with academic precedent. Our system rather presupposes that since past attainment is the claim to recognition, when once a man has got inside he has a prescriptive title to remain, unless some extraordinary reason forces his expulsion.

It might very well be that such a system would modify to an extent also the place of the degree in education. But the sacredness of the degree is in any case open to question. It is now a title to intellectual respectability of the peculiarly unfortunate sort which combines with a claim to superiority, denied to its non-possessor, a thinly veiled recognition by the informed that its real content is merely nominal, and that it can be counted on to stand for little more than the fact that its holder has passed four years at a given locality, with enough attention to his books in the intervals of more important occupations to prevent naturally lenient instructors from condemning him as beyond question unfit. The justification of the degree is solely the aid it renders in the desperate enterprise of inducing in the general mind a sense that scholarship has its points; it marks therefore a failure of more fundamental motives, and its claims can not be pressed too hard until other efforts have been exhausted. Probably it will have to be retained along with other relics of medievalism, though there is no reason why at the same time there should not exist a large increase of students without full technical preparation, or the ability to pursue their academic work at length, who will cease to be regarded as so much dead weight, and be recognized as having human if not scholastic claims. And at least if the degree is to hold its place, this apparently can only be on condition of the already strong tendency to make its meaning exceedingly elastic. The endeavor to keep the degree true to what traditionally has constituted the education of a gentleman, disguised under the name of liberal, is really the attempt to keep up the fiction of a learned class marked off by formal insignia, under the pretence that there is only one royal road to culture.

And if now we turn in conclusion to the second aspect of the social purpose of education—the equipping of the narrower class of intellectual leaders on whom will always depend the initiation and the steering of social progress, I venture to think that this is a much less important problem than the former one, for the simple reason that here the root of the matter lies in large measure beyond the province of educational machinery in the lap of nature. The exceptional man is pretty

apt to look out for himself. He will thrive probably in spite of our attempts to educate him quite as much as because of them. The most that society can do is to have plenty of opportunities ready to his hand, and see to it that unnecessary and artificial restrictions do not prevent his free expansion. Naturally the college will receive all alike, the exceptional and the mediocre; and one part, though a secondary part, of its function will doubtless be to bring to light the man of brilliant parts. But its machinery will be wasted if it sets itself to this as its main task. To what extent the university with its specialized training is likely to cooperate to the same end, it is not easy to say. Certainly it has not done a great deal in the past, and its specialized and academic character is against it. There is a well-founded distrust of the capacity of the academic mind to set the standards of society. Even its good points are against it. There is such a thing as being too reasonable, if reliance on reason makes us, as it tends to do, over-critical and afraid of action such as anticipates grounded theory. The specialized university can produce the economist and the legal expert; beyond this it is not so clear. What distinguishes the real leader from the expert is precisely that broad outlook and human sympathy which constitutes culture. And specialized training, uncorrected, tends also to obscure that feeling of the need for submitting scientific reasoning in state matters to the test of popular agreement, which alone is consistent with the democratic ideal. Upon the college, then—when nature does not ignore the school and the schoolmaster altogether—most of the task seems likely to fall. If it can devise some plan to meet the special needs of the exceptional man, that he may not be encouraged merely to keep pace with the mass, so much the better; if not, he will probably make his own opportunities. Meanwhile nothing in the attempt should jeopardize the main end of the college, or induce it to give way to that seductive tendency to exalt overmuch the claims of cleverness, which is the peculiar temptation of higher education.

REFORMING THE CALENDAR

By OBERLIN SMITH

"YES, tempus fugit," remarked a philosophical gentleman of African descent, as I sat in his barber's chair remarking that my time was limited, "but," he went on to say, "we should not speak of time flying, for *we* fly through time." This seems logical, and new, but in whatever way we regard time we must certainly measure it; and we now measure it rather foolishly—not so foolishly, however, as by many systems in the past. Reformers of all ages have struggled with the question of how to divide three-hundred-and-sixty-five-and-about-a-quarter into any convenient groups of units. A division into months was doubtless suggested by the motions of the moon, but the twenty-nine-and-a-fraction days forming her cycle were not commensurate with the earth's yearly cycle and nothing but confusion could arise from trying to use a lunar month for practical purposes. Certain attempts in ancient days led to such inconvenient time-keeping as was shown in the old Jewish year, which varied from 353 to 385 days, the months approximating a lunar cycle and an extra one being inserted sometimes each second, and sometimes each third, year.

The ancient Egyptians used twelve 30-day months and five odd days over, with no leap-year. This brought about the pleasing result of having the calendar year begin at all possible times in the astronomical year. Thus a complete cycle, to bring summer back again so that it would occur in summer, was about 1,461 years in duration. As nobody waited to see the end of it, not many people were greatly inconvenienced. When the Julian year was established in 46 B.C. with 365 days, and an added day each four years, the seasons stayed where they belonged much better, but they naturally had gotten somewhat awry by 1582 A.D., when the present Gregorian year was established. It would seem that if Cæsar and Pope Gregory XIII. (and also the Persians, in the early middle ages) thought the calendar of enough importance to be reformed by radical changes, we, in this day of rapid reforms, should be willing to make the slight changes necessary to get rid of the illogical and troublesome system now in use.

Among the annoying inconveniences of our present calendar are the changing of the dates in each year at which the respective seasons, months and weeks begin, causing various holidays and other special days to be movable as regards the day of the week and often to be postponed to a new date, upon the day following, when they happen to

occur on Sunday. Another nuisance is the inequality in the length of the months and the random fashion in which the various lengths occur —this irregularity even requiring the memorizing of pretty little poems, such as "Thirty days hath September, etc." Still another evil is the starting a new year about one-third way through a season instead of each beginning at the same time. Still another is the ten days discrepancy between the beginning of the calendar year and the solar year, there being no good reason why they should not start together—say at the winter solstice, instead of a little after, as at present.

There is hardly room herein to fully discuss the question historically or to analyze all that is now being done to effect a reform in our curious calendar. It may, however, be interesting to get an idea of a modern view of the case by compiling a résumé of a series of articles upon calendar reform, written by various students of the subject during the past year or so.

Referring to *Science,* Vol. XXXII., p. 154, a communication from Professor Reininghaus advocates changing the present Gregorian calendar by starting the year with six months of 28 days (four whole weeks each) followed by a half-month of two weeks, then by six more such months and another half-month. This completes 364 days of the year. To them is added a non-week day, followed in leap-years by another day.

On page 306, same volume, Dr. Slocum quotes Mr. Cotsworth, of England, as recommending thirteen 28-day months, putting the extra one in midsummer and calling it "Sol." He then puts in an extra day, calling it "Christmas," and each four years inserts a "Leap-day."

On page 513 Professor Patterson quotes Sr. Hesse, of Chili, as advocating thirteen 28-day months, plus one or two necessary non-week days, suggesting that the new month shall come in winter and be called "Trecember." Professor Patterson, however, prefers to have the new month in summer and suggests "Roma" for its name. He also advocates that we number the hours of the day from 1 to 24, instead of putting in duplicate groups of twelve each, as now.

On page 556 Mr. Dabney agrees with the 13-month advocates above mentioned. He refers to possible difficulties in arranging the legal holidays, which seem to depend somewhat upon politics and public enthusiasm. He thinks that outside of the four old-fashioned ones, they had better be made to occur on Sundays so there would not be too many of them to interfere with regular weekly occupations.

On page 628, Dr. Cohen fears differences of opinion among followers of the various great religions, should some calendar reform be made universal. He proposes that we do not name the days at all, but simply number them from one to seven in each week as do now certain of the religious denominations, and as did the ancient Hebrews.

On page 757 Professor Chamberlin advocates giving plenty of time to a careful study of a possible new calendar, but suggests that the best arrangement would probably be twelve months of four weeks each and four extra weeks, one placed at the end of each of the seasons. These intercollated weeks, as we might term them, would be used for closing up accounts in business and school-work, taking short vacations, etc. The 365th day he would make New Year's Day, with a leap-day added every four years. He proposes special names for the extra weeks, as, for instance, Christmas, Easter, Julian and Gregorian.

On page 917 Dr. Hopkins criticizes Professor Chamberlin's scheme and suggests instead, the adoption of eight 4-week months and four 5-week months, the latter to be 3d, 6th, 9th and 12th of the year. To avoid any greater space than seven between Sabbath days he advocates running all weeks consecutively and having every fifth year an extra so-called leap-week. This leap-week would be omitted each forty years, save the 10th and each 20,000 years except the 10th. This, he figures, would bring everything out all right in the long run, but he doesn't suggest how many of us will live to see that it goes through properly.

In volume XXXIII., page 64, Professor Barton analyzes the Chamberlin and Reininghaus schemes and objects to starting winter as late as the first of January, and also to so-called quarter-years having an odd week appended as making it awkward for the future timing of contracts, etc., especially those which are based on monthly periods.

On page 688, the late lamented Professor Webb recommends, as a temporary matter, that the years from 1918 until 1924, inclusive, shall each consist of 52 weeks or 364 days, and that we then shall commence a system of having each fifth year a long one containing 53 weeks, or 371 days. Subsequent to the last date mentioned he would abolish the term "month" and have as units only weeks and days, numbering all the days of the year consecutively and knowing them by such numbers. The inaccuracies of thus counting consecutive weeks indefinitely onward would be corrected by omitting the long-year in year dates divisible by 50, except at different intervals about 400 years apart.

On page 690 Professor Kent regards favorably the usual four quarters and twelve months, but would, in common years, give February 30 days by robbing two of the present 31-day months, and would give February an extra day in leap-year.

On page 690 Mr. Clifford has referred to the movements for reforming the calendar in France, Holland, Switzerland, etc., which have been going on for more than twenty-five years past without exciting much attention in this country. The general consensus of opinion abroad seems to favor the simple scheme of four quarter-years each with two 30-day, and one 31-day months, with a non-week day at the end of common years, and two of them in leap-years, the second one to be at

the end of the second quarter. The year 1917 is recommended for making the change as allowing plenty of time for discussion and decision throughout the world, and as fitting in properly to start with the first day of the year coincident with the first day of the week.

On page 803 is a quotation from an article in *Nature*, by H. C. P., which relates that certain propositions for calendar reform have been unsuccessfully introduced in the English Parliament. One of these called for the simple arrangement above described by Mr. Clifford and others, while the second one calls for seasons of 28-, 28- and 35-day months. The author points out the absurdity of the second scheme, with its perplexities in arranging for monthly salaries of servants, etc.; and discourages any movement of the sort as unnecessary, and as interfering with the present continued succession of the 7-day weeks, fearing that any change could not be accepted on religious and sentimental grounds. The whole tone of his communication is perhaps a little too pessimistic to make it worthy of a serious place in an article upon reform.

On page 283 of the March, 1912, number of this magazine, Dr. Super, in an article upon "Time and Space," recommends the same simple and scientific arrangement of four 91-day seasons, etc., recommended by Clifford and others.

Referring in general to the schemes of the various authors above quoted, we certainly should not consider any of the 13-month projects, simply because thirteen is not divisible by four, the number of seasons that we have assumed desirable. Months of 28 days would be still more awkward, if some of them were rated as half-months, as suggested in one of the essays. The suggestion of four 12-week seasons, each followed by a holiday-week, would seem to be rather confusing as it would mix two different sorts of units, seasons and weeks.

The scheme for a temporary change for the next thirteen years, and then another change, making every fifth year a week longer than the others, would also be very inconvenient. We should try to make the years all as uniform with each other as possible, only varying them the one day at certain intervals as seems to be forced upon us by nature. Obviously, commercial values such as interest, rents, salaries, etc., based upon a 52-week year would not be suitable for a 53-week year. Another suggestion that we merely lengthen February and shorten some of the other months in an arbitrary and irregular way does not seem worth considering, as little real improvement would be effected.

The Dalziel Bill, which has been presented in the British Parliament having months with 28, 28 and 35 days for each season, seems utterly impracticable, especially in the matter of calculating monthly wages, rents, etc. The Pearce Bill, however, presented earlier in Parliament, with four 91-day seasons and an extra non-week day, etc., seems to be

almost ideal, and agrees, in its main features, with the proposals that have been made by various scientists in Europe for several years past, commencing perhaps with M. Flammarion and referred to later as the "Grosclaude Project," with headquarters at Geneva. It seems to have been considered favorably also by some of the Esperanto congresses.

Such simple schemes embody the only logical method of handling the subject, as the primal conditions of any calendar reform that we may hope to succeed in adopting throughout the civilized world are, first, simplicity, and, second, the least possible change from our present system. It probably will be generally conceded that if we make a change we had better retain the present division of the year into four seasons, into twelve months, and into weeks of seven days each. Of these the natural and unalterable units are the year and day. The difficulty throughout the ages has been to make one of these commensurate with the other when nature has kindly made their ratio about 365.2422.

After completing these four seasons, by whichever of the exact arrangement of months that may be considered best, we have, in any of the cases, 364 days. The remaining non-week day in common years simply fills a little gap and may be called by any appropriate name. It doubtless should be a holiday, but preferably belonging to the old year. In leap year the extra day should be put in the middle of the year, thus making each half-year alike, it being considered the final day of the first half and being a holiday. It perhaps might be called "leap day" or, preferably, something more euphonious.

A primal advantage of this general scheme is that the beginning of each year and any certain day of any year, counting numerically from the beginning, always happens the same day of the week and, furthermore, that each season always begins and ends with the same day of the week, because the 91 days are divisible by 7.

In any of these good schemes, where we keep years almost the same length, varying by only one day in leap year, we meet with the academic objection that the weeks do not run forever in an unbroken line of seven days each. This, of course, would make no trouble in social or commercial life, but it might be contrary to the religious scruples of some people as occasionally giving them an 8-day interval between two sabbaths, instead of always seven days. This could be gotten over, however, if necessary, by calling the additional day a sabbath and thus having two together once a year, and in leap year twice a year. A better plan would perhaps be to let the extra day of the year be Christmas, thus allowing only the holiest of all days to crowd certain two sabbaths a little apart. To those people who believe in the great importance of an exact sequence of 7-day weeks, which they suppose to have been maintained since the christian era, and which must always be maintained, it may be suggested that if they ever are traveling

westward their weeks are perforce lengthened to more than the standard 168 hours. Should they happen to go all the way around the world they make their weeks so long as to be obliged to throw out a whole day into the Pacific Ocean, thus giving them one 6-day week. If, on the other hand, they travel eastward, their weeks are shortened, and by the time they get home they must have endured one 8-day week. This being the case, how can they logically object to a calendar reform which would only have the same effect upon them, at certain long intervals, as would an extended eastward journey.

Whatever reform is made, one point especially should be insisted upon (one that the calendar reformers seem to have neglected) and that is to start the new year about the twenty-first of December instead of ten days later, as we now do. Thus the calendar year and the solar year would have a definite relation to each other—as they properly and logically should have. Here again an objection might be offered that when the change was made some certain two sabbaths would come too near together, or too far apart, but as this would only happen once for all (it is to be hoped for many thousand years) the difficulty would not be a serious one. Even this could be avoided, however, simply by choosing a suitable year for the grand change.

To those persons who object to the first season (winter) beginning 21 days later than it does now, it may be pointed out that we of the north temperate zone are apt to have many more cold and disagreeable days in March than we do in November and that the early part of September is but a continuation of summer. The occasional frosts which we have in June that so often "spoil the peach crop" (for the time being!) may perhaps also give a hint that summer might just as well commence a little later than it now does. To the thought that we should logically place the middle of the cold season at the solstice, when the earth receives the least sunshine, it may be replied that there is a *lag* in meteorological phenomena which is the interval between certain causes and the effects which follow. The retardation is due to a variety of physical actions, as the retention of heat in the earth, water and air, and so forth. The length of this lag is uncertain and irregular, but probably a half-season is a near enough period to allow. All of our weather is so variable that it is not feasible to attempt running it upon an exact time-table.

It should be understood that the word "season" is used herein synonymously with "quarter." The latter is of course frequently used in business matters as a division of a fiscal year. There is no reason, however, why the commercial quarter-year should not be identical with the climatological and sentimental unit.

Incidental to this calendar reform, but not necessarily a part of it, is the numbering of the hours of the day from 1 to 24 instead of by the

present absurd method, involving two sets of twelve hours each, all marked with the necessary appendages, "morning," "afternoon," "evening," "A.M.," "P.M." and so forth. All this is just as sensible as it would be to name months enough for half a year only, and then to repeat them during the last half, with some cabalistic letters attached to distinguish them from the first set. It is surely more logical and definite to commence the day at midnight and number it straight through, as we would number any other series of parts belonging to a whole. If our clocks, watches and railway time-tables were numbered in this way, it would require but a few months for everybody to become entirely conversant with the new method. The writer has long carried his watch with the hours from 13 to 24 marked in red figures below the usual black ones. Any old time-piece can be so marked and the new scheme thus automatically becomes familiar.

The improved numeration has long been in use by the big Canadian railways and by various railways in Europe. It is also used by the general public in some places on the continent, but just to what extent I am not fully informed. Only to-day the news is cabled that the 24-hour scheme has been adopted in France.

Some years ago this numeration was advocated and practised at its conventions by so scientific a body as the American Society of Civil Engineers. Thus, they habitually, upon their programs, etc., appointed afternoon meetings at 14 o'clock; dinners at 19.30 o'clock and dances at 21 o'clock, and so on. They have for a few years allowed the matter to drop, but it is to be hoped only temporarily.

In the diagram below I have tabulated the chief points of the Geneva scheme before referred to, except that I have used the German spelling "kalender" which I suggest for future use, to distinguish it from the old "calendar" previously used. It is better thus to place the 31-day months at the beginning of the season rather than at the end; firstly, because in such case there are two less of the old months to change the length of than is the case by the other plan; and, secondly, because with a 30-day month at the end of the season, the "leap day" following June and the "extra-day" following December can, if desired, be considered as part of the month preceding them, thus giving it thirty-one days. This need not affect the position of the weeks, but it might be convenient in some cases involving monthly stipends, as in paying for domestic service, etc. Thus, there never would be thirty-two days to consider as perhaps belonging to a month, which would be the case with the other arrangement.

An inspection of the table will show the fortunate circumstance that all of our present American holidays occur on week-days, with one exception. This is Lincoln's birthday, which comes upon Sunday, February 12. It is perhaps better so, as another holiday, Washington's

birthday, follows so soon, coming on Wednesday, February 22. Decoration Day occurs Thursday, May 30; Independence Day, Wednesday, July 4; Labor Day, Monday, September 4; Columbus Day, Thursday, October 12; Thanksgiving Day, Thursday, November 23 or 30, as may be determined; and Christmas, Monday, December 25; Election Day need no longer be "the first Tuesday after the first Monday in November" but can be fixed simply on November 7. Such movable holidays as Easter and other ecclesiastical dates which are partly dependent upon the moon will, of course, not be fixed; but they will occur more uniformly than at present.

In England May Day will occur on Wednesday, May 1; and Michaelmas on Friday, September 29. In France, their glorious July 14 will always occur upon Saturday.

In the table, the extra day is named "Silvester," as suggested by the European reformers referred to. An alternative arrangement might be made, however, by calling it something else, or by using Christmas Day for this position in the calendar, instead of six days earlier. This need not offend any christian sentiment as this day is often moved now from Sunday to Monday; and there was originally considerable dispute as to where in the year it should be placed, no definite arrangement, I believe, having been made previous to the fifth century. My own preference, however, would be to leave Christmas where it is, and have the extra day as another holiday, replacing our present "new years."

KALENDER FOR 1918, A.D., AND EVER AFTER

Days in Seasons	Name of Month	Number of Days	Dates of Sundays					Leap Year
Winter.....	January.....	31	1	8	15	22	29	
91	February....	30	5	12	19	26		91
	March.....	30	3	10	17	24		
Spring.....	April.....	31	1	8	15	22	29	
91	May.....	30	5	12	19	26		91
	June.....	30	3	10	17	24		
Leap Day...								1
Summer.....	July.....	31	1	8	15	22	29	
91	August.....	30	5	12	19	26		91
	September...	30	3	10	17	24		
Autumn.....	October.....	31	1	8	15	22	29	
91	November...	30	5	12	19	26		91
	December...	30	3	10	17	24		
Silvester.....		1						1
Year.....		365						366

Each year, with its first season, first month, first week, first day and first hour to commence at midnight following the winter solstice—in the morning of what we now call December 22. Leap years to be the same as in the Gregorian calendar.

To establish the new calender it would, of course, be necessary to have uniform legislation agreed upon by all the principal civilized nations of the world. They would then simply issue an edict that at a specified future time, the first day of December was to be considered as the tenth and that when the following January 1 arrived the new scheme should commence and remain in force forevermore. Such a ten-day shortening of a month should not frighten any one when it is remembered that this identical proceeding was followed when the Gregorian calendar was established, the change as it happened then also requiring ten days.

When England changed from O.S. to N.S., 170 years afterward, a shortening of the year by eleven days occurred, and nobody seems to have been scared. Of course it could easily be arranged by law that notes and other financial promises and contracts would mature after an expiration of the given number of days of intended duration when they were dated. This little trouble would occur but once, and all things would run smoothly ever after, with a vast improvement in the convenience of reckoning dates and days of all kinds, including our personal birthdays.

The proposed civilization of the calendar might be decreed at any time, but as it will doubtless take years to make the change popular, it might be well to fix upon December, 1918, for a hoped-for performance of the operation. In that year, Saturday falls upon the day of the solstice, December 21. This, when the ten days shortening was made, would be the thirty-first by the new scheme and consequently would be "extra day," "Silvester," or whatever it might be called. The following day being Sunday, would give the start as the first of the new year by the new calendar. Thus, nobody could be prejudiced at the beginning by putting any two Sundays further apart, or nearer together, as would be the case in other years than 1912, 1918, 1924, etc.

In regard to the practical promotion of calendar reform, it would seem as if some of the large scientific bodies of this country should act together, and get into close affiliation with the interested people in Europe, who seem to be farther advanced in their ideas than we are. Thus an influence might be brought to bear upon the various civilized governments of the world which would some time result in victory. Should not an international kalender society be formed in the near future?

BASIL VALENTINE: A SEVENTEENTH-CENTURY HOAX

By PROFESSOR JOHN MAXSON STILLMAN

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ALL who are at all familiar with the early history of chemistry will recall the prominent place given to a writer who wrote under the name of Basil Valentine and in the early history of the sciences was generally assigned to the fifteenth century. His knowledge of chemistry was for that time remarkably advanced, falling chronologically, as it appeared, between the writings of the medieval alchemists, Albertus Magnus, Arnoldus de Villanova, Raimundus Lullus and Roger Bacon, and those of the later authors Paracelsus and Agricola. The histories of chemistry by Ferdinand Hoefer in France 1842–3 and by Hermann Kopp of Germany 1843–7, which have served largely as the basis for later histories of that period, both accepted from earlier sources the works of Basil Valentine as of the latter part of the fifteenth century, though with some evident uncertainty as to this period. Both Kopp and Hoefer mark the work of Basil Valentine as closing the alchemical period, and ascribe to Paracelsus the inauguration of the medical chemical or iatrochemical period.

Examination of the writings of the so-called Basil Valentine and of the writings ascribed to Paracelsus made it apparent that many of the most important facts of chemistry as well as many of the theoretical ideas which Paracelsus announced and made the basis of his revolutionary influence upon chemistry and medicine were contained in the works of Basil Valentine.

Thus to Basilius was awarded the priority of the announcement of many chemical observations and experiments and their applications to the uses of medicine, and to Paracelsus was credited the making of these ideas influential for progress.

Paracelsus was born in 1493 and died in 1541. The chemical literature extant previous to his time and which may claim to be of importance, apart from the slight contributions of the ancients, was comprised in manuscripts or printed books attributed to Gheber, Albertus Magnus, Raimundus Lullus (or Lully), Roger Bacon and Arnoldus de Villanova, though many of these writings are known to be forgeries of much later date than are the genuine writings of these men.

The works of Paracelsus were published, some few during his life time, but most of them from twenty to fifty years after his death. They were collected and published by Huser in Basel in 1589–91,

excluding however his surgical books, which were already, however, in print at that time, or at least the important ones. Many of the writings included in Huser's collected works of Paracelsus are in the opinion of modern scholars not genuine. Huser himself included some which he thought were not genuine. The important point here, however, is that the body of the writings ascribed to Paracelsus was in print by 1591.

There exists no evidence that up to this time any one had ever heard of Basil Valentine. No known reference has been found in any author before 1600, no original manuscript nor copy of probably prior date has been known to exist.

The writings of Paracelsus, or attributed to him, give evidence that he possessed a familiar and extensive knowledge of the chemical facts and experimental methods of his time. He mentions the names of those from whom he learned the art and they are names that are known as students or practical chemists of the period, such as Trithemius, and Sigmund Füger, the miner and mine owner. Paracelsus published many chemical facts and observations which were new to the literature of chemistry. The names of zinc and bismuth appeared to have been first mentioned by him. He characterized these as resembling the metals (that is, the seven ancient metals) and called them bastards of the metals, because they lacked malleability and ductility. He recognized a basis of discrimination between alum and the vitriols, in that while the latter have metals as bases alum has an earth for base, a good distinction for that time. He showed how an amalgam of copper might be obtained by precipitating copper from its "vitriol" (or sulphate) by means of iron and then rubbing the precipitated metal with mercury. He describes the action of oil of vitriol upon iron and notes that "air rises and breaks forth like a wind."[1] He notes the bleaching action of the fumes of sulphur upon red roses, notes the preparation of metallic arsenic "prepared like a metal," and the formation of "fixed arsenic" (non-volatile arsenic acid) by the action of niter upon white arsenic. He first uses the term "reduction" for the preparation of the metals. He mentions the use of an infusion of nut galls for detecting iron in mineral waters and describes the separation of muriatic acid from mixture with nitric acid by the use of silver.

In Paracelsus first appears the theory of the chemical elements which dominated chemical thought until the rise of the phlogiston theory, viz., the notion that all substances are composed of the three elements mercury, sulphur and salt. From Gheber, Lullus and others of his predecessors he was familiar with the notion that mercury and sulphur were constituents of the metals, but he extended the theory and gave it a more consistent form by interpreting the mercury as the

[1] Hoefer, "Histoire de la Chimie," 2d ed., II., p. 12.

element which gives volatility, sulphur as that which burns, and salt as that which neither burns nor volatilizes in the heat.

Paracelsus also used and advocated the use of many metallic preparations for medicines, as preparations of mercury, antimony, lead and arsenic. He recognized the poisonous character of them when used in excess, but emphasizes that poisons may be used to advantage in medicine in proper doses.

These and similar announcements scattered through his writings marked Paracelsus as a chemist of importance, if they were derived from his own experience, and not borrowed from some other source.

But Paracelsus was a physician who had incurred the antagonism and enmity of the great majority of the orthodox medical profession. He had repudiated the doctrines of Galen and Avicenna, their almost sacred authorities. He held their knowledge up to contempt in lecture and in writings and savagely attacked the practises and the ethics of the profession. Their opposition he met with arrogant defiance. As his following increased, the warfare between the Galenists and the Paracelsists increased in bitterness, and for a century after his death the contest continued with bitterness. The result was a partial victory for the chemical medicines introduced by Paracelsus, but there also resulted a gradual discrediting of Paracelsus by the growth of a mass of legends derogatory of his ability and character, most of which have since been shown to be baseless, but which his faults and weaknesses served to make credible. While this warfare was still at its height, at the beginning of the seventeenth century, there appeared a number of printed books, published by Johann Thölde, purporting to be from old manuscripts and to be written by a monk of the Benedictine order—Basilius Valentinus. By far the most important of these was the "Triumph-wagen des Antimons," or "Triumphal Chariot of Antimony," (1604), which contained, with much that was mystical and obscure, as was the fashion of most chemical literature of the time, nevertheless a remarkably clear treatment of the preparation and properties of many compounds of antimony, and of their application to medicine. This work attracted deserved attention, and other works which appeared under the same author's name about the same time and later shared in this popularity. That all of these were by the same hand as the "Chariot" is certainly not true, especially the later publications.

It was soon noticed that nearly all the above mentioned contributions of Paracelsus to chemistry were contained in the work of the newly discovered author, and often more thoroughly explained and more comprehensively treated than in Paracelsus, though sometimes the opposite was the case.

Basil Valentine had also spoken of zinc and bismuth and called them bastards of the metals. He had also noted the action of oil of

vitriol upon iron, though he made no mention of the escape of "air" in the process. And so with most of the above mentioned experimental data of Paracelsus. Basil Valentine had also announced the doctrine of the three elements—mercury, sulphur and salt—though he had not made the interpretation of their significance as qualities of bodies as had Paracelsus. Basil Valentine had also advocated the use of metallic preparations of antimony, mercury, etc., in medicine, and he also had abused and ridiculed the physicians of his time.

Indeed, to any one who compares the many similar data and ideas in the two collected writings the conclusion seems unavoidable that one of these authors drew from the other, or else that both drew from the same common third source. But no such common source was known or is yet known. If then the writings of Basil Valentine were authentic and of the fifteenth century as assumed, then assuredly Paracelsus must have had access to a copy of the manuscripts and have freely utilized the contents without reference to the author. As he freely refers to other authors in approval or disapproval, this omission was notable. If the writings of Basilius were forgeries of the time of the publication, then they were written some sixty years after the death of Paracelsus and were borrowed not only from him, but presumably also from Agricola and minor writers whose works appeared in the latter half of the sixteenth century.

In favor of the genuine character of the newly published author spoke the real value of the contributions in the "Triumphal Chariot." Why should any one who could write such a work conceal his identity and lose the credit for it by attributing it to another? It was not probable. This conclusion was doubtless also encouraged by the disrepute in which the name of Paracelsus was held by the medical profession and the scholarly classes of the time. Here was an explanation for the apparently profound knowledge of chemistry which Paracelsus seemed to possess, but to whom they gave no credit for scholarship of any kind.

Doubtless also the name and standing of the editor and presumptive possessor of the original manuscript, Johann Thölde, a chemist, owner in the salt-works at Franckenhausen in Thuringia, and member of the Chamber of Councilors (Rathskämmerer), gave additional presumption of the genuineness of the find.

Against the originality of the writings in so far as they were to be assigned to an earlier century, was in the first place the fact that previous to their publication by Thölde no knowledge existed of any such person as Basilius Valentinus. No writer of the fifteenth or sixteenth century had referred to any such author.

Examination of the records of the order of St. Benedict in Germany or at Rome failed to discover any such name on the rolls. No original manuscript was preserved or placed in evidence at any time.

Thölde explained in his preface to one of the early publications that it was from a very old manuscript which he had great difficulty in deciphering and translating from the original Latin script. From the evidence of the books themselves little could be learned. The author claimed to be of German nationality from the region of the Rhine, and to be an inmate of a Benedictine monastery and a brother of that order. They contained no reference to any contemporary persons or events which might serve to locate their exact time.

From allusions to the use of antimony in the making of types for printing, it became evident that the date of the writing was not earlier than the latter half of the fifteenth century, and from several allusions to the application of chemical medicines to the cure of the "Morbus Gallicus" (or "French Disease") which was known to have made its appearance in Europe about the end of that century (1493 is the date usually quoted) it was evident that the writing could not have been earlier than about the close of the fifteenth century. While this internal evidence established the end of the fifteenth century as the earliest possible date no internal evidence indicated that the date of the authorship was necessarily earlier than the date of publication. Though there have apparently always been critics who have disputed the genuineness of the find,[2] yet the general opinion gained credence and authority that Basil Valentine was the assumed name of an unknown writer of the end of the fifteenth century, and that to him, therefore, was to be credited the priority of announcement of a large part of the more prominent facts and theories of chemistry which already existed in print in the works of Paracelsus. It was taken for granted and asserted that Paracelsus had had access to a copy of his works or of some of them, and therefore had appropriated his ideas without acknowledgment. No less an authority than van Helmont (1577–1644) states that Paracelsus lived more than a hundred years after Basil Valentine and had appropriated his knowledge without due credit.[3]

In time also certain legends grew up and became adopted into current literature which seemed to give a greater definiteness to the existence of the assumed author. Gudenus in his history of Erfurt (1675) stated that a monk of that name was a member of the Benedictine order in that city in 1413. Though Gudenus cited no authority for this statement, and the records of the monastery gave no confirmation, and though, for reasons above mentioned, the works of Basil Valentine could not have been written before the end of the century,

[2] Ferguson, "Bibliotheca Chemica," 1906, mentions Stolle, 1731, Kestner, 1740, the author of "Beytrag zur Geschichte d. Höheren Chemie," 1785. Waite ("The Triumphal Chariot of Antimony," London, 1893) quotes Placcius, 1708, as skeptical of B. Valentine.

[3] Cf. Van Helmont, "Opera Omnia." Francofurti, 1682. "Tria Prima Chym.," p. 386.

yet this statement added in time a certain weight to the belief in his reality. Still later apparently arose a tradition that in 1515 the Emperor Maximilian I. had instituted a search to establish the identity or existence of the alleged Basil Valentine, though with negative results.[4] This statement found its way into most of the histories of chemistry and is still frequently met with. The importance of the acceptance of the statement lies in the fact that it assumes that at that early date Basil Valentine was known and an object of interest, instead of a century later. Kopp, who in his "History" (1843) repeats and credits the statement, in his "Beiträge" (1875) calls attention to the baselessness of the rumor.[5] It may be that there is confusion here between the Emperor Maximilian I. (1459–1519), and Duke Maximilian I. of Bavaria (1573–1651). (This explanation has been suggested, though the writer can not now locate the source of the suggestion.)

The question of priority in important contributions to the history of chemistry and the question as to plagiarism by Paracelsus or imposture by Thölde both hinge upon the fact as to whether the Basilius writings were written about 1500 or about 1600, and from what has preceded it would seem that the presumption is in favor of the latter date and that the burden of proof lies with the supporters of Basil Valentine.

But the evidence is not closed with the above-mentioned considerations. Though in his "History of Chemistry," Kopp had accepted the prevalent view that the writings of Basil Valentine were of earlier date than those of Paracelsus, his researches did not cease with the publication of that work. In 1875 in his above quoted "Beiträge zur Geschichte der Chemie" he entered anew and in great detail into the problem. One by one he traces back through the literature the sources of the traditional statements upon which are founded the supposed identification of the period of Basil Valentine. His continued investigations of the manuscripts in the libraries had failed to develop any originals or copies of apparently earlier date than the printed works. He announces his opinion that the evidence favors the judgment that the works of the supposed Basil Valentine are of later date than Paracelsus rather than earlier. He hesitates, however, to accuse Thölde himself of intentional deception, as nothing was known against his reputation, and it could hardly be supposed that he would not have published such a work as the antimony monograph under his own name if he really wrote it.

Eleven years later (1886) in his latest work, "Die Alchemie," and as the result of failure in the meantime to obtain from any source any evidence favoring the prevalent theory, he reiterates more decidedly his

[4] Schmieder ("Geschichte d. Alchimie," 1832), who refers to Motschmann, "Erfordia literata," Erfurt, 1729–32.

[5] Kopp, "Beiträge," III., p. 112.

belief in the fraudulent character of the work and that Thölde himself was the writer as well as the editor of the alleged Basil Valentine works. With reference to this Thölde, Professor John Ferguson, of the University of Glasgow, the first of British students of chemical literature of this period, in his "Bibliotheca Chemica" (1906), gives some pertinent information and ideas.

Ferguson calls attention to the fact that Thölde published a work in his own name "Haliographia," on salts, salt works, etc. (1603). It consists of four parts. Ferguson says:

> This fourth part, it is said, appeared in 1618[6] with the name of Basilius Valentinus. It was certainly published at Bologna, 1644, "Ex manuscriptis et originalibus Fratri Basilii Valentini ordinis S. Benedicti collecta," without any mention of Thölde. This may be all quite straight, but somehow it needs explanation. Especially when we remember that the works of Basil Valentine are said to have been not merely edited by Thölde but actually written by him. It is a dilemma; either Thölde had appropriated the work of Basil Valentine without acknowledgment, or else he has put out or allowed to be put out, a work of his own under the name of Basil Valentine. In his discussion of this subject in the "Beiträge z. Gesch. d. Chemie," Kopp has occasion to consider the connection between Basil Valentine and his reputed editor, and he is inclined to regard Thölde as editor merely, on the ground that as the works contain a good deal of chemistry that was new for the period, he can not see why Thölde should have ascribed that knowledge to one to whom it did not really appertain. He considers that there is nothing in Thölde's life otherwise which would give occasion to believe him untrustworthy. Well, he may have been quite an honest man, but appearances are rather against him and one can sympathize with Dr. Caius: "What shall de honest man do in my closet? Dere is no honest man dat shall come in my closet!" It makes one suspicious that if Thölde could tacitly absorb into his "Haliographia" without acknowledgment a tract which afterwards appeared under Basil Valentine's name, there is no reason why he should not have used the name of Basil Valentine all along as a stalking horse and under presentation of that shot his alchemy. But on this occasion he had forgotten his pseudonymity.
>
> Subsequently ("Die Alchemie," 1886, I., pp. 29–33) Kopp changed his views regarding Thölde and Basil Valentine, and said that there is reason to think that the writings of the latter were composed about the end of the sixteenth or the beginning of the seventeenth century instead of a hundred years earlier; that Basil Valentine's name is fictitious; that the publication of these writings was an intentional literary deception; and in that case that the responsibility must rest with Thölde. It is very remarkable that in this view, so decidedly, uncompromisingly, different from that enunciated by him eleven years earlier he should have come to exactly the same result as that elaborated one hundred years earlier and expressed with emphasis by the author of "Beytrag," a work which, so far as I have observed, was unknown to Kopp, as I do not think that he ever refers to it.

Professor Ferguson in his comments on Kopp's change of views between 1875 and 1886 seems to have overlooked or forgotten that even

[6] Schmieder, "Geschichte der Alchemie," in his bibliography of Basil Valentine gives 1612 and 1644 as dates of these editions.

in 1875, while he was disposed to acquit Thölde of the authorship, he nevertheless clearly expressed his opinion that the authorship followed rather than preceded the time of Paracelsus.[7] Eleven years later, however, after failing to find new evidence from any source, he comes to the conclusion that the most reasonable assumption is that Thölde himself was the author. There is therefore nothing "uncompromisingly" different in his views at the two periods rather is it a case of the carefully guarded expression of a gradually maturing conviction. It is not without significance in connection with this Thölde to note that he also published (1605) an alleged "Kleine Hand-Bibel, etc.," of Paracelsus, claimed by Thölde to have been reproduced from a long-hidden manuscript of Paracelsus. Sudhoff in his bibliography of Paracelsus[8] pronounces this an undoubted imposture, reserving for another place the discussion as to whether Thölde were himself the author. This discussion, however, I have not met with.

Since Kopp's time other competent students of the science of that period have come to similar conclusions. Thus M. Berthelot[9] referring to "antimony," says that this name is far earlier than the mythical personage called Basil Valentine, to whom has sometimes been attributed the discovery of this substance, and under whose name have appeared various works which did not appear previous to the sixteenth century.

Dr. Karl Sudhoff, the eminent student of the early history of medicine and author of the monumental bibliography of the literature of Paracelsus, and whose researches into the books and manuscripts of the period in question have been most exhaustive, covering many years of labor, has recently[10] unquestionably assigned Basil Valentine's writings to the beginning of the seventeenth century.

Dr. Franz Strunz, another well-known scholar in the history of chemistry and natural philosophy of the medieval and renaissance periods, asserts with similar conviction:[11]

> The writings of the so-called Basil Valentine, who never existed at all, are by Joh. Thölde. He, however, was in post-Paracelsan time.

Mention may also be made of Lasswitz[12] and Lehmann,[13] amongst modern students of the period who have expressed themselves as accepting the post-Paracelsus origin of the Basil Valentine literature.

It would seem, therefore, in the light of this evidence and in the

[7] "Beiträge z. Ges. d. Chemie," III., pp. 117–119.

[8] "Versuch einer Kritik der Echtheit der Paracelsischen Schriften," I., 465.

[9] "Introdn. a l'étude de la Chimie," p. 279.

[10] "Beiträge aus der Geschichte der Chemie, dem Gedächtniss von G. W. A. Kahlbaum," 1909, p. 254.

[11] In his "Paracelsus, Leben und Persönlichkeit," 1903, p. 30.

[12] "Geschichte der Atomistik," etc., 1896.

[13] "Aberglaube und Zauberei," 1908.

absence of any support but tradition for the reality of a fifteenth-century writer under the name or pseudonym of Basil Valentine, that we are not only justified, but in justice obliged to conclude that the works in question were written at or about the period of their production; that in all probability Joh. Thölde was the author of the more important and earlier ones; that Paracelsus was not guilty of stealing his chemical knowledge from a unique copy of some unknown original, and that not Basil Valentine nor Thölde, but Paracelsus, was the first recorder, if not the first discoverer, of a considerable series of chemical facts, and the originator of some influential theories and applications, which appeared for the first time in his publications.

But the established channels of three centuries of chemical tradition are hard to divert. Despite the verdict of modern scholarship, recent text-books and manuals of the history of chemical science are slow to accept and assimilate the changes involved.

Thus, in the "History of Chemistry," by F. P. Armitage (1906), it is still assumed that Basil Valentine or some one writing under that name lived at the end of the fifteenth century, and consequently such statements occur as the following:

> With Valentine's successor, Paracelsus, there begins a new school of chemistry.
>
> Accepting Valentine's philosophy of the three elements, mercury, sulphur and salt and like him reading this into all matter indiscriminately, Paracelsus was able to give a theoretic basis to his sense of pathologic phenomena.

So also Hugo Bauer (translation of R. V. Stanford, "History of Chemistry," 1907), while stating that "new life was brought into this ruinous state of affairs in the second half of the seventeenth century[14] by Basil Valentine," yet says:

> The most decisive influence upon chemical thought in this period proceeded from the physician Paracelsus, and his successors Van Helmont and de Boe Sylvius. Basil Valentine had already put forth the view that all substances consisted of the three elements sulphur, mercury and salt.

Bauer also gives much space to the chemical work of Basil Valentine and overlooks the similar work of Paracelsus.

Sir Edward Thorpe[15] refrains from assigning any definite period to Basil Valentine, saying:

> He was supposed to be a Benedictine monk who lived in Saxony during the latter half of the fifteenth century: but there are grounds for the belief that the numerous writings ascribed to him are in reality the work of various hands. The attempt made by Maxmilian I. to discover the identity of the author was unavailing, nor have subsequent inquiries had any better result.

Thorpe, however, gives a summary of the more important chemical

[14] This may be a misprint for the fifteenth. The subsequent method and order of treatment would bear out such a supposition.

[15] "History of Chemistry," 1909.

facts from these writings, and in the later references to Paracelsus, which are in line with the judgments of earlier rather than of recent scholarship, no reference is made to the similar contributions of Paracelsus, thus conveying the inference of the priority of the works of the pseudo-Basilius.

Even Ernst von Meyer,[16] whose text-book is deservedly the most popular of recent histories, has not broken loose from the traditional mode of treatment. Referring to the writings in question, he recognizes that "their genuineness has become more and more questioned, and rightly so." But perhaps misled by the alleged "investigations, which were carried out at the command of the Emperor Maximilian I.," he still assumes that "a large number of facts were recorded by the writer, who lived about a hundred years before the books were published."

This rumor of the investigations by the Emperor Maximilian I. (who died 1519) which, as above stated, Kopp has pronounced without substantiation, is the most persistent of the traditions which have served to give the impression that the Basil Valentine literature is antecedent to Paracelsus. Naturally enough, accepting the truth of this statement, Meyer omits from his treatment of Paracelsus the enumeration of chemical data previously noted in Basil Valentine, and in referring, for instance, to the doctrine of the three elements, which to the best of our knowledge was original with Paracelsus he says:

> With respect to the constituents of organic bodies Paracelsus adhered to the old assumption that the latter were composed of the three elementary substance-forming qualities (elements) mercury (Mercurius), sulphur and salt.

In view of the results of the scholarly researches into the history of this period during the past thirty years by Kopp, Berthelot, Sudhoff, Strunz, Lasswitz and others, it is time that the Basil Valentine literature should be assigned to its proper and subordinate place in history. There is indeed great need of a thorough revision of the history of chemical discoveries and theories from the earliest times up to the rise of the phlogistic theory. The task will be no easy one, but the value of the work thoroughly done will well repay the labor.

[16] "History of Chemistry," 3d edition, translated by McGowan, 1906.

THE HINDU-ARABIC NUMERALS*

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AT present the Hindu-Arabic numerals hold nearly unlimited sway in the realm of number. In China, in Japan, in southeast Asia, and in parts of India, it is true, they are employed only by the upper classes and by foreign traders; but all over Europe, in Australia, and in North America, they are supreme; while in South America and in Africa they are used wherever civilized men make arithmetical computation.

Scarcely ever has a more wonderful device been perfected. By means of these characters prodigious calculations can be made. Through tables, logarithms, and counting-machines amazing swiftness and accuracy are obtained. Their power and their scope seem almost limitless.

And yet there was a time when they were confined to a few districts in India, and not heard of by the rest of mankind; when they were cumbersome and inert and difficult to use; when they were no better than number signs which had been developed elsewhere, and not nearly so well known. Even when their superiority was manifest, their progress into other lands was uncertain, difficult, and slow. The story of the development of the Hindu numerals and of their conquest of the world make an interesting but oft-forgotten chapter in the history of civilization.

The idea of number originates in sense experience. The conception of *two* and *three* as different from *one* rests fundamentally upon experience in dealing with one thing and with more than one thing. The ideas of an object and of several objects which the mind forms through the eye or through the sense of touch constitute the basis upon which all knowledge of number rests. Thus gradually in infancy or during the childhood of the race are obtained the conceptions of what we now call in English "one," "two," and "three."

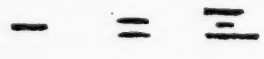
In the lower stages of culture only dim ideas of higher number exist, and the lowest, basic numbers are used in combination to express

* In preparing this paper I have had the assistance of Dr. Louis Charles Karpinski, who has put at my disposal the results of research in a field which he is making peculiarly his own. By permission of Messrs. Ginn several illustrations are reproduced from Smith and Karpinski, "The Hindu-Arabic Numerals," Ginn and Company, 1911, the best work upon the subject, and a work of which I have made free use.

what is more numerous. Thus, three and one or three and two take the place of four and five. This method was actually incorporated into the systems of the Phenicians and the ancient Hindus. Indeed, the habit persists in the minds of people later on, when they possess many number symbols and the ability to use them in calculation. While the more acute nowadays can without great difficulty comprehend four and five, yet five will frequently be apprehended better as a combination of two and three, while almost inevitably six will be thought of as a combination of three and three, and seven as made of three and four.

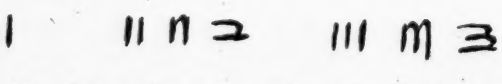
Nevertheless as the mind of man becomes more powerful, and the need for calculation becomes more frequent, larger numbers are made use of, even though they can only be comprehended as combinations of smaller ones. The designation of these number ideas soon becomes necessary, and it must be made both for the eye and for the ear. For the eye this may be done by symbols; for the ear by words. Thus, the Greeks may write ϙ′ (90) and call it ἐνενήκοντα; the Romans XL, and call it *quadraginta.*

The designation of these number ideas either by symbol or by sound is exceedingly difficult for the reason that number ideas are necessarily abstract. It is true that the lower, which represent a few objects, can be designated by pictures. So, man may originate the symbols for his lower numbers in the same manner that he first makes the symbols for his words, by ideographs or picture-drawings. In old Chinese the rude representation of a man designates man. Similarly the Chinaman writes a simple stroke to represent a single object; two strokes to represent two objects; and three, to represent three:



The Hindu once employed the same device, except that his strokes were usually perpendicular:

These symbols were used wherever men began to write their numbers. They were employed by the Latin peoples, and as the Roman numerals are still in common use. In cursive form they are the numerals which we use to-day:



Such graphic designation of number cannot be carried very far, however, and arbitrary symbols must soon be employed. Thus, for four the Hindu wrote two strokes crossed:

Whether this is a combination of four strokes, and so a true ideograph, can not be known. For six the Chinaman writes

Thus a series of signs may be accumulated.

In many cases the need for a series of number symbols arises when considerable progress has been made in the construction of an alphabet. The alphabet then furnishes a series of signs which follow each other in definite sequence, and as signs are fairly well understood and familiar. The result is that the letters of the alphabet are employed to designate the number ideas. This was done by the Hebrews, who make use of their twenty-two letters, and by the Greeks who had the twenty-four letters of their alphabet with three archaic signs interspersed.

As an example of this alphabetic designation the Greek system may be taken. The letters accented were the numerals: α', 1; β', 2; γ', 3; δ', 4; ϵ', 5; ς', 6; ζ', 7; η', 8; θ', 9; ι', 10; κ', 20; λ', 30; μ', 40; ν', 50; ξ', 60; o', 70; π', 80; φ', 90; ρ', 100; σ', 200; τ', 300; υ', 400; ϕ', 500; χ', 600; ψ', 700; ω', 800. The intervening numbers were expressed by combination; thus, $\gamma' = 3$ and $\iota' = 10$, therefore $\iota\gamma' = 13$; while the numbers for the thousands were expressed by sub-accenting the lower symbols; thus $\beta' = 2$, $_{,}\beta = 2000$.

Here is a system comprehensive and excellent for the mere writing of numbers. It was, however, because of the numerous signs employed, cumbersome and complex. For example, in multiplication, where our nine numerals now in use require a knowledge of forty-five combinations—one times one, one times two, one times three, and so on—the Greek system with its twenty-seven characters required the memorizing of three hundred and seventy-eight—α' times α', α' times β', α times γ', and so forth. Other arithmetical processes were correspondingly difficult.

Another scheme, apparently much simpler, consists in using only a few letters or signs. As an example, the Roman system may be taken. For one a single stroke was employed, I; while groups of strokes were used for the numbers following, II, III, IIII. Five was designated by a symbol of its own, V, which was once thought to be a representation of the thumb and four fingers held up, but this theory has been abandoned. For ten, X was employed, the origin of which is not entirely clear. A study of the inscriptions, however, affords ground for the belief that the Romans in counting from one to ten used one, two, three, four, five, six, seven, eight, nine strokes; then, to avoid

confusion, denoted ten by drawing a tenth stroke over the nine parallel ones,

and that this was abbreviated to two strokes crossed, X. The upholders of this theory assert that five, half of ten, was then denoted by V, half of X. For fifty, L was used; for one hundred, C; for five hundred, D; for one thousand, M. The numbers in between were expressed by combination: LX = 60, DCXV = 615; or by addition to or subtraction from the nearest one of the seven symbols: XII = 12, IX = 9.

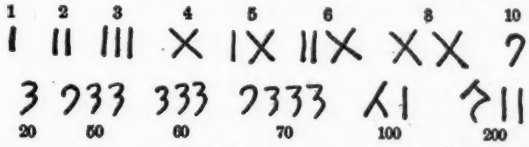
The advantage of this system lay in the fewness of the symbols employed. Where the Hebrew had twenty-two characters and the Greek twenty-seven, the Roman made use only of seven. Because of this fewness the value of the characters could be easily remembered. On the other hand the smaller number of characters employed made necessary the greater use of combination. The Greeks had a symbol for sixty or for ninety, but the Latins must place together several numeral signs of smaller value so that the combination would equal the total required In Greek 60 might be expressed by ξ′, one character; in Latin by two, LX. The more complex the number the greater became the relative cumbersomeness of the method. In Greek 1863 could be expressed by ,αωξγ′; in Latin it would be MDCCCLXIII. The result of these cumbersome combinations was that with the Roman numerals it was virtually impossible to make calculations of any intricacy, and exceedingly difficult to make even simple ones. They might be employed for mere designation, as they are to this day used to express dates and to distinguish the pages of a preface; but for addition, subtraction, multiplication, division, and intricate arithmetical work, the Roman mathematicians were driven to use the Greek symbols and methods.

Meanwhile in the east other systems of numeral notation had been developed, some of which, in modified form, are in use there at the present time. The Babylonians were expert calculators; and the Chinese invented a notation which they still have. It was in India, however, that a system arose destined to supersede all others among civilized people.

There were probably some numerals in use among the Hindus a thousand or more years before our era, but no records exist earlier than the time of Asoka, in the third century B.C. From this time on occur inscriptions which contain some of the native number symbols. Two systems may be discerned, which possess respectively the characteristics of the Roman and the Greek.

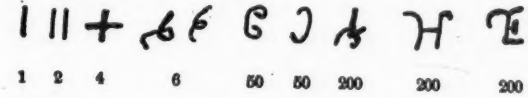
In the Kharosthi inscriptions of the third century B.C. four numerals occur, the origin and meaning of which are evident:

In the Saka inscriptions of the first century before Christ more characters appear, and the resemblance to the Roman becomes striking:*



This system is constructed of the symbols for 1, 4, 10, 20, 100, and so forth, as the Roman is built upon the I, V, X, L, C, D, and M.

In the same period another system was invented in which greater flexibility and power were obtained by using an increased number of signs. In the third century B.C. certain of King Asoka's inscriptions in the Brahmi writing contain these characters:*



In the following century an inscription in the Nana Ghat cave near Poona in central India has even more interesting ones:*

Here the 1, 6, and 7, which we now use, appear plainly; while the 2 and 9 are in rudimentary form. About two hundred years later inscriptions in the Nasik cave contain all of the important Hindu numerals:*

* From Smith and Karpinski, "The Hindu-Arabic Numerals."

Here the characters for 1, 4, 6, and 7 are easily recognizable, while the 2, 3, 5, and 9 can be developed without difficulty.

This system is neither different from that of the Greeks nor superior to it. Neither has a zero, and in neither have the characters a value of place. That is, all of the important numbers must be designated by signs of their own. In our system 2 moved one place to the left becomes 20, but in Greek $\beta' = 2$ and $\kappa' = 20$. So, in the Nasik inscription 2 and 20 are designated by characters separate and distinct.

In this far there is similarity; but while the Greeks used the letters of their alphabet, the Hindus did not. The meaning of some of these signs, such as the strokes for 1, 2, and 3, is apparent, but the origin and meaning of others are not known. They may have been made from alphabetic characters, but as yet no theory has been substantiated.

It may be seen that all of the different systems of numerical notation which had been developed, whether in China, in India, or in Greece, had the same general characteristics: there was no zero, and the symbols had no place value. Because of this it was necessary to employ a great many different symbols. Such a system might be used for mathematical calculation, but it was bound to be complicated and intricate. What was needed was a system with fewer signs; but when this was constructed, as it was among the Romans, and the Greeks of Solon's time, it was so rigid and inflexible as to admit of no progress in mathematics. Something altogether different was needed.

Gradually, by processes of which we know little, a revolution was wrought in all mathematical work and new numeral systems were developed. This revolution was effected by the use of the counting-board, or, as we now call it, the abacus, from a Greek word the meaning of which is in dispute. At first all calculation was probably mental or performed upon the fingers, but as time went by, a mechanical device was perfected wherever men strove to make readier and more elaborate computations. This device is said to have been invented by the Chinese, though of such tradition there is no certain proof At all events it was used by the Chinese, the Babylonians, and the Hindus in immemorial times. The Greeks and the Romans had it; and it continued to be used in Europe throughout the middle ages. According to the "Dialogus de Scaccario" of the twelfth century, the officials of the exchequer reckoned the king of England's revenue by means of it. To this day it is employed generally in Russia, and in schools wherever children are learning to count.

Fundamentally the abacus consists of a board or table marked off in parallel columns within which counters can be placed. The principle is the same if the counters are strung along parallel wires. The important thing is that on the abacus each column has a value of its own, a *value of place*. Thus, several numerals may be employed with

reference to the counters in the first column, for example, our 1, 2, 3, 4, 5, 6, 7, 8, 9. Then these same numerals may be employed for the second, but they will now have in their new place a new value, let us say, ten times as great, so that a 2 in the second column will denote 2 tens, or 20. And so in other columns, which give the value of 100, or 1000. By this means the entire number of numeral signs may at once be reduced to the number of signs used in the first column. Without the abacus the Greeks must have nineteen signs in counting from one to a hundred: on the abacus there is need only of nine.

The place value assigned on such an instrument would depend upon the practical system of counting which had been developed. Just as nowadays the workman, or the boy playing a game, will tally five, and then begin another five, and then another, thus making a group of fives which he can handle easily, rather than one longer series, so the practical calculators of bygone days worked with fives, or sixes, or tens, or twenties. Various systems have been used. The Babylonians employed the sexagesimal, reckoning by sixties. Some of the African tribes count by sixes, and some of the New Zealanders are said to use elevens. The duodecimal or twelve system has passed away, but in the *dozen* we still preserve traces of it ourselves.

As a rule, however, the system has been none of these, but counting has been done by fives, by tens, or twenties, and this simply because it has been based upon the antique but persistent habit which man has of counting upon his fingers. To this day there is a widespread custom of reckoning roughly by fives. The Mayas of Yucatan used the vigesimal or twenty system; so did the men of Palmyra in Zenobia's time, and the Syrians before the days of Mohammed. The same is said to have been true of the Celts, and the French seem to preserve traces of it now when they say *quatre-vingts,* four twenties, for 80. But after all that system which has been most widely adopted is the decimal, based upon all the fingers of the two hands.

The Hindus came to employ the decimal system, as did the Greeks and the Chinese. It found place in the written language as well as in the numeral notation; but, as has been said, it existed only in complicated form. Thus, the Greeks and the Romans had words to express numbers from one to ten, as they had signs. In Greek εἷς and α΄ denoted one; δέκα and ι΄, ten; after which there were words and signs for twenty, thirty, and so on, at intervals of ten up to one hundred; followed by words and signs at intervals of a hundred. In between, the numbers were expressed by combination: ἕνδεκα (one-ten), eleven; δύο καὶ τριάκοντα (two and thirty), thirty-two. The Roman system was entirely similar, except that it employed fewer signs. The Hindus used the decimal system even more consistently, since they preserved it in counting beyond thousands indefinitely.

Thus, the decimal system was developed in language and in numeral notation at the same time that it was being employed in the construction of the abacus. In each case its origin was due to the habit or practise among people of counting upon the ten fingers until they came by custom to reckon in tens. In each case, however, the decimal system was unwieldy in that it was built up upon a large number of words and signs. It was the function of the abacus to make it simple by reducing the number of signs.

Since the Hindus employed the decimal system, so, on an Indian counting device the counters in the second column had ten times the value of those in the first; the ones in the third ten times the value of those in the second, and one hundred times the value of the counters in the first. It was necessary now for the Hindus to use only the signs which in their present form are 1, 2, 3, 4, 5, 6, 7, 8, 9. Thus, 591 would be represented by 5 | 9 | 1. In like manner 501 would be 5 | | 1, the middle space being vacant since there were only five hundreds and one unit, but no tens. Among the Greeks it is probable that the same method was worked out. In this manner the number signs could now be attached to a definite place, and so had a definite place value. This is the most important step which has ever been made in mathematical science.

But a difficulty arose when the calculation was transferred from the abacus-board and became a written operation. 591 could be transferred without difficulty, since the digits by mere juxtaposition would preserve their place value; but 5(0)1 taken from the abacus might be 51, since the *vacant* place was no longer indicated. Accordingly mathematicians were led to invent a character to stand for the vacant space. By so doing they perfected the system of place value, since they could now show that even when there was no one of the nine numerals in a particular place, the value of the place remained, and the values of the adjoining places could be maintained. The invention of a symbol for nothing is the crowning, transcendent achievement in the perfection of the decimal system, and lies at the base of all subsequent arithmetical progress. It is the peculiar triumph of the Hindu mathematicians to have made this contribution to the science of number.

A symbol for nothing was employed among the Chaldeans, but merely for notation, and apparently never in calculating. In the cuneiform incriptions it occurs as

Among the Hindus it was at first a dot (.). In this guise it was borrowed by the Arabs, who still use it. Very soon, however, the Hindus began to employ a circle, 0. The earliest known use is in an inscrip-

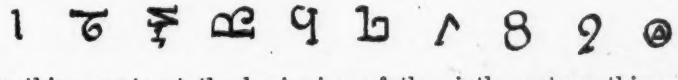
tion at Gwalior, 876 A.D. Fifty and two hundred and seventy are written respectively

So at last the decimal system was complete, and it had been worked out in the Hindu numerals. It remained now to carry them from India into the countries nearby.

The introduction of the Hindu numerals into Europe is one of the obscurest matters in history. Most probably the truth can never be completely discovered. This is as it should be, since the adoption of these numerals was natural and slow, and not premeditated or artificial. After a while they were in use among the merchants of the east, who carried them along the highways of the world's commerce It may be that they entered into countries upon bales of goods or in the accounts of traders, and so would be unnoticed by the scholars. Perhaps for a long time the local mathematicians would know nothing of them, and would continue to use the symbols and the systems of their forefathers. It may be said, however, that the fame of the Hindu characters was spreading into the countries near by even before the addition of the zero. In 662 Sebocht, a Syrian ecclesiastic, writing in a monastery on the Euphrates, refers to the "science of the Hindus . . . and of the easy method of their calculations, and of their computation, which surpasses words. I mean that made with nine symbols." No doubt there were others in the neighboring lands who came to know of this wondrous art.

Of one thing there is no doubt: the Arabs soon adopted the Hindu numerals, and when they spread their conquest across the world they carried these numerals with them. In the ninth century a group of brilliant mathematicians were employing them at Bagdad, while a long line of scholars used them in a slightly different form, the *Gobar* numerals, in Spain. From the Arabs these numbers were taken by Christian Europe, and for this reason came to be known for a long time as Arabic numbers.

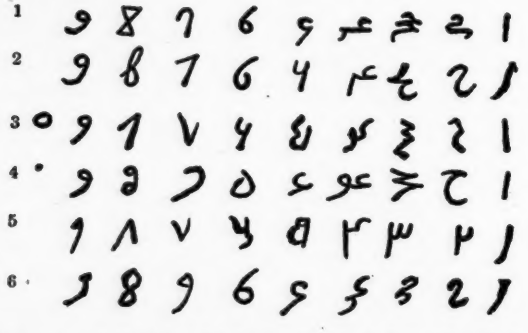
There will always be the question whether in some form these numerals were known and used in southern Europe before the coming of the Arabs. It is not likely that this matter can ever be entirely determined. In an eleventh century manuscript of the "Geometry" of Boethius there is a passage where certain numerals are introduced, curiously like the Hindu symbols:



As Boethius wrote at the beginning of the sixth century this was at one time thought to indicate an early introduction of the symbols, or

even an independent origin; but it is now as certain as such things can be, that the passage is a medieval interpolation, and was not written by Boethius. The subject is exceedingly obscure, but there is reason for thinking that these characters, *apices,* as they were called, were used in Europe some time before the interpolation was made.

However this may be, there was apparently among the Christian peoples of Europe no widespread use of the ten symbols as they were used by the Hindus, until the Christians borrowed them from the Saracens of Spain. The date of their introduction from Spain cannot be determined, but it is fairly certain that Gerbert, who as Sylvester II. was Pope from 999 to 1003, brought them back from the Saracens among whom he had studied. He seems to have described the nine Gobar numerals without the zero:*



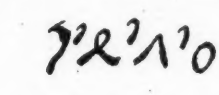
After a while some of the monkish mathematicians learned of the symbol for nothing. O'Creat in the twelfth century employed it in three forms, o, ō, ר. At this time when the new numerals are used the whole subject is confused. Sometimes the Hindu symbols are used without the zero; sometimes the Roman characters with it, the Roman characters then acquiring a place value. Thus, when O'Creat writes 1200, he puts it I.II.ר.ר.; for 1089 he uses I. O. VIII.IX. At the beginning of the twelfth century Radulph of Laon used a mixture of Gobar and Roman characters. About the same time an unknown German scribe wrote them in a manuscript now in the Hof-Bibliothek in Vienna.

The mathematician who had most to do with spreading the Hindu numerals in Europe was Leonardo Fibonacci, a merchant of Pisa, who was born in 1175. In 1202 he completed his "Liber Abaci," or arithmetic, rewriting it in 1228. He it was who, when employing the Hindu numerals, first clearly explained their use. The progress was furthered when Alexander de Villa Dei about 1240, and Johannes de Sacrobosco about 1250, wrote popular treatises. Of Sacrobosco's "Algorismus" there remain now nearly one hundred manuscripts. It was due to him particularly that the Hindu signs came to be known in Europe as *Arabic numerals.*

* From Smith and Karpinski, "The Hindu-Arabic Numerals."

The Hindu characters were now known, but they came into general use very slowly, for the same reason that the metric system is not adopted immediately nowadays. The Roman characters, computation on the abacus, and various devices held their own obstinately through force of custom. Moreover, before the era of printing no knowledge could be spread rapidly among the mass of the people, and for the most part the counting of the ordinary man could be done upon his fingers.

A coin of Roger of Sicily is dated with the Hindu numerals in 1138. In 1390 an Italian coin is so dated; in France, one of 1485. There is a Scotch piece of 1538, but apparently none for England until 1551. A French manuscript of 1275 contains a treatise upon these numerals. They are used in the inscription upon a grave at Pforzheim in 1371, and upon one at Ulm in 1388. In 1470 they are used to date a book:*



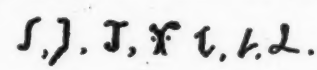
In 1471 the pages are so numbered in a work of Petrarch printed at Cologne.

They were still used in curious and confused combinations. In a work of 1470, 147 and 150 are written respectively*

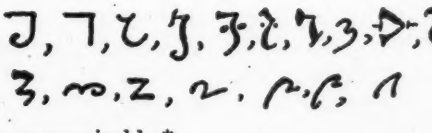
CC2 stands for 202. About the same time 12901 means 1291, m.cccc.8II stands for 1482, and MCCCCXL6 for 1446. Somewhat earlier cα is written for 104; somewhat later 1vojj for 1502.

The forms of the numeral signs varied as much as they do now upon the slates of children learning in school. These forms were not well fixed until after the general use of printing.

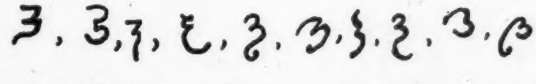
One is frequently written i. Other forms are*



Two is often z, so that iz = 12.*

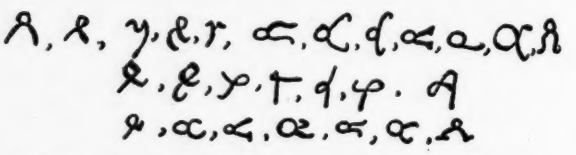


Three is usually recognizable.*

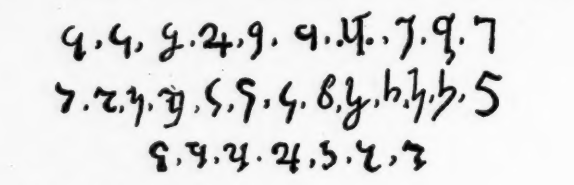


Not so four, which has varied greatly.*

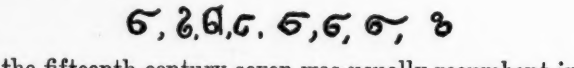
* From Smith and Karpinski, "The Hindu-Arabic Numerals."



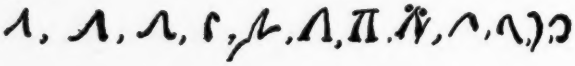
Five has changed a great deal, though it can usually be recognized.*



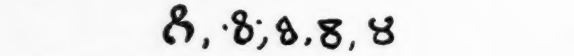
Six has changed but little.*



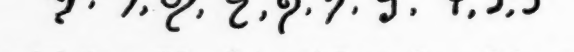
Up to the fifteenth century seven was usually recumbent in posture.*



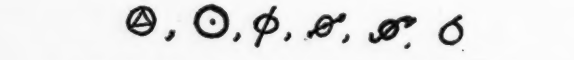
Eight has preserved its shape.*



So has nine for the most part.*



The symbol for nothing has varied greatly, and in an arbitrary manner.*



The name of this last symbol is interesting. The Hindus called it *sunya,* void. In Arabic this became *sifr* or *as-sifr.* In 1202 Leonardo Fibonacci translated it *zephirum;* in 1330 Maximus Planudes called it τζίφρα, *tziphra.* During the fourteenth century Italian writers shortened it to *zeuero* and *ceuro,* which became *zero,* now in general use. Meanwhile it had passed more nearly in Arabic form into French as *chiffre,* and into English as *cipher,* taking on new significations. Perhaps the schoolboy of to-day, who speaks of getting "zip" for an answer, is himself reverting to the Arabic.

After the Renaissance the Hindu numerals gradually supplanted other forms, and by the seventeenth century the process was nearly complete. From Europe in turn they have spread over the world, until they are now in general use wherever civilized man is living,

* From Smith and Karpinski, "The Hindu-Arabic Numerals."

except in some countries of the far east, near where they had their origin.

Such is the story of the numerals, and such is one phase of the development of the mind of man. In the childhood of the race we see him counting upon his lips, his fingers, or his toes. Then he assigns to his ideas symbols, and finally with prodigious difficulty gives to them a value of place. But when at last this has been done, and when he understands what he has done, his mind can travel upon the wings of light. In a twinkling he is able to make calculations which in physical terms express æons of time or stupendous distance along the pathway of the infinite. And all this he can do with ten little symbols, which can be written upon a shred of paper, or told off upon the fingers of his hands.

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DR. ALEXIS CARREL,

Rockefeller Institute, New York City; recipient of the Nobel prize in medicine.

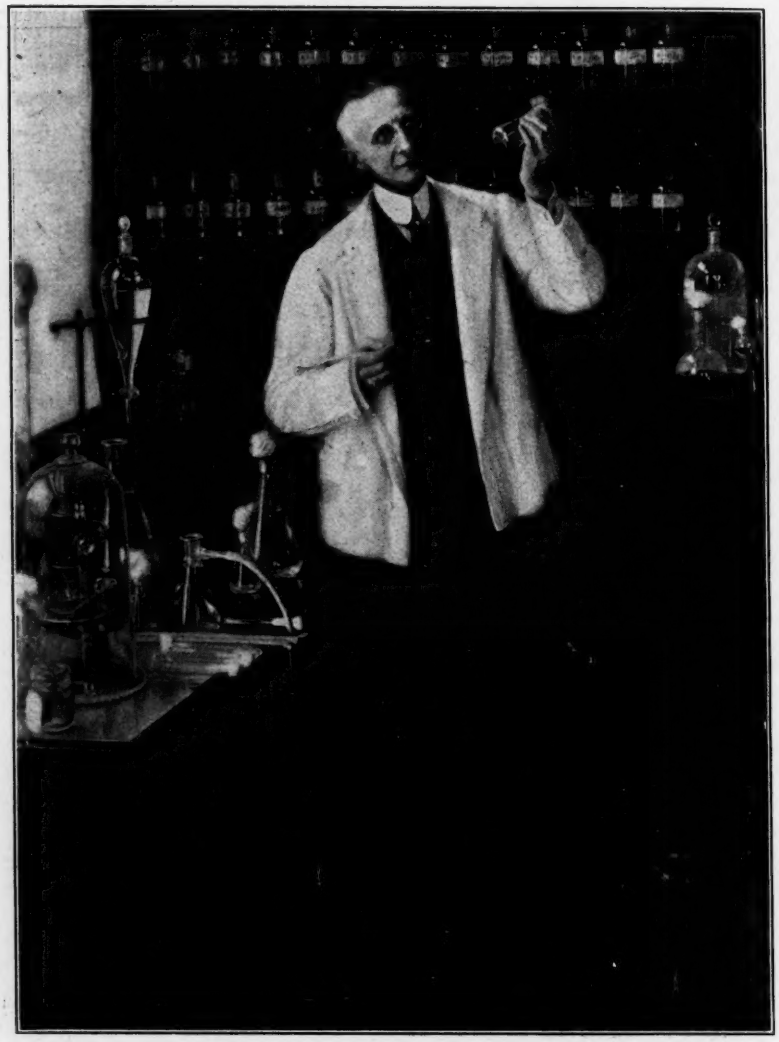
THE PROGRESS OF SCIENCE

THE AWARD OF THE NOBEL PRIZE IN MEDICINE

THE Nobel prize in medicine has this year been awarded to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, New York City. This is an honor not only to the distinguished investigator, but also to the institution which has given him opportunity and to his adopted country. It may not be altogether satisfactory to our national pride that among some forty Nobel prizes conferred in the sciences only two have come to America, and that the men in both cases have been born abroad. Professor Michelson, who received the prize in physics, is, however, a graduate of the U. S. Naval Academy, and Dr. Carrel has done his work here. It is doubtless the case that obtaining a Nobel prize is a game in which to win skill and chance must be combined. We have native-born investigators who deserve as high honors as MM. Sabattier and Grignard, between whom the prize in chemistry has this year been divided, or Mr. Dalen, of the Stockholm gas works, to whom the prize in physics has been given. Still it should give us pause to reflect that no obvious injustice has been done by the failure to award a Nobel prize in medicine, physics or chemistry to a native American; perhaps also to consider that in the Rockefeller Institute, in addition to the director, Dr. Simon Flexner, of American birth but foreign parentage, and Dr. Carrel, there are at least three other foreign-born and foreign-educated investigators—Dr. Jacques Loeb, Dr. S. J. Meltzer and Dr. Hideyo Noguchi, to whom a Nobel prize might with justice be awared.

The work of Dr. Carrel is fairly well known, its character being such as to be comparatively interesting to the general public. He has extraordinary skill in technique, such as would give him a fortune beside which the $38,000 of the Nobel prize would be small, if he were willing to be diverted from scientific research to surgical practise. His work also bears witness to imagination and patience, which when united to skill supply the essentials of successful investigation. It is easy to point out that Dr. Carrel has followed lines opened up by others; that organs had previously been transplanted and kept living outside the body; that Professor Harrison, of Yale University, anticipated him in the methods of cultivating living tissues; but this in no wise detracts from the importance of the work he has accomplished. As he himself said at the reception given to him at the College of the City of New York attended by President Taft and the French ambassador: "Almost every step in scientific progress which appears to be due to the efforts of one individual is, in reality, the result indirectly of the unknown scientific work of many others."

Dr. Carrel certainly is not responsible for the exaggerations of the newspapers. It is an excellent thing that the New York *Times* and other daily papers of New York City have become aware of the news value of the scientific work accomplished at the Rockefeller Institute. The reports are usually based on papers presented before scientific men and on articles printed in scientific journals; the investigator may suffer from headlines, inaccuracies and the exploitation of the sensational, but these may become eliminated, and the public may become



DR. SIMON FLEXNER,

Director of the Laboratories of the Rockefeller Institute, from a painting by Adèle Herter, of New York City, presented to the University of Pennsylvania by the colleagues and students of Dr. Flexner at the time he was professor there.

educated to the human interest of scientific research.

It may be regarded as a cause for congratulation that the administrators of the Nobel bequest have this year made some of the awards to younger men actively engaged in research—Dr. Carrel is not yet forty years old—rather than to men of distinction whose life work is practically complete, if only because this was the condition under which Nobel bequeathed his fortune. By his will it was specified that the prizes should be awarded to those persons who shall have contributed most materially to benefit mankind during the year immediately preceding; that no preference should be given to Scandinavians in the awards, and that the entire income should be used for five great prizes. The first condition may have been difficult to meet, but its spirit could have been followed, as has been done this year in the case of Dr. Carrel, by conferring the prize for work done recently, rather than for work done a generation ago, or as even this year in conferring the prize for literature on Dr. Hauptmann. It must still be regarded as unsatisfactory that a considerable part of the income has been used to establish Nobel Institutes at Stockholm, and it can scarcely be supposed that Dr. Gustrand, the Swedish oculist, would have received the award in medicine last year, or Mr. Dalen, the head of the Stockholm Gas Company, would have received it this year, had Nobel's intentions been fulfilled. It is ungracious to make criticisms when there is no reason to doubt that the administrators of the bequest are doing what they believe to be for the best advantage of science. At the same time, if no criticisms had been made, it is by no means certain that even more of the income might have been diverted to local uses, for in the statutes approved by the Swedish courts it was made possible to award the prizes only once in five years.

VITAL STATISTICS AND THE DECREASING DEATH RATE

THE recently published seventy-third annual report of the registrar general of births, deaths and marriages in England and Wales gives an excellent summary of the vital statistics of England with convenient international comparisons. As is well known both birth rates and death rates have decreased in practically every nation in the course of the past thirty years. A comparison of the quinquennial period 1881–85 with 1910 for several countries gives the following rates per thousand population:

	Birth Rates		Death Rates	
	1881-5	1910	1881-5	1910
England	33.5	25.1	19.4	13.5
Prussia	37.4	30.5	25.4	16.0
France	24.7	19.7	22.2	17.9
Italy	38.0	32.9	27.3	19.6
Russia	49.1	—	35.4	—
Australia	35.2	26.7	15.7	10.4
United States	unknown		unknown	

In this table "unknown" is written after the United States to emphasize our lack of vital statistics. Recent data from Russia are also lacking, but in that country and in the United States as elsewhere both birth rates and death rates have decreased in such a way as to leave a tolerably constant increment of population.

This correspondence, however, is by no means complete. Where both birth rates and death rates are high the increment of population tends to be larger than where they are low. This holds in general for nations, districts and social classes. The Slavonic nations, in spite of their waste of human life, are increasing more rapidly than others. The tenement house districts of New York City have a large infant mortality, but they swarm with children, whereas in the rich districts, there is less than a child to an apartment. The most striking instance on a large scale is France, with a birth rate some five lower and a death rate

some five higher than England, which has given to France a stationary, and last year a decreasing, population.

It is a question of fundamental importance whether the relation between the birth rate and the death rate will be maintained under existing conditions so as to give an increased or, at all events, a stationary, population. Will both continue to decrease, will they remain approximately as at present, or will the balance of the nineteenth century be lost as has apparently happened in France? The death rate has been halved by the practical abolition of war, pestilence and famine in their grosser forms, and by alleviation of their milder aspects—improved conditions for the struggling classes, the limitation and mitigation of disease, and better conditions of living. There is abundant room for further improvement, and it is stated by reputable authorities that the death rate can be halved again. But this is impossible; indeed, it seems that in certain nations the death rate has now reached its minimum. Australia and New Zealand now report a death rate of ten. This means that in a stationary population the average age at death is 100 years. For every infant that dies, a man must live to be 200 years old, or ten men live to be 110. This is almost beyond the limit of possibility. In 1910 the death rate in England and Wales was 13.5. This means in a stationary population an average age at death of 74 years, and as more than one seventh of all infants die, the average age of those surviving infancy would be about 85. The expectation of life of those 40 years old, which has not increased in the course of the last sixty years in spite of the lower death rate, is 28 years, so they die at the average age of 68 years.

The paradox is explained by the age constitution of the population. Owing to the high birth rate in England prior to 1876 and its subsequent decrease, an unusually large percentage of the population is from 5 to 40 years old, at which age the death rate is on the average only five per thousand. The population of England has about doubled by natural increase since 1850. Consequently old people more than sixty years old represent a population only half as great as children, and if a stationary population should hereafter be maintained, the percentage of old people would double. Indeed, as the death rate of children and of those under forty has decreased and will still further decrease, the percentage of old people will increase perhaps threefold. At present there are in France about as many people over sixty-five as there are children under five, while in England there are less than half as many, and in Russia with its high birth rate and death rate there are less than a third as many. The death rate of those over sixty-five is about 100; it has not decreased in the past sixty years, and is not likely to decrease considerably in the future. These old people now form about one thirtieth of the English population and contribute about three and a third units to its death rate; when they increase threefold, they will contribute ten units, and, if other conditions remain the same, the death rate will rise from 13.5 to 20. There will surely be a further decrease in the death rate of those under forty, but this will increase the number of those over forty, and will tend to increase their death rate. Probably a death rate of 15—an average age for those surviving infancy of from 75 to 80—is as low as will ever be permanently maintained by any nation. One may well wonder whether the birth rate will cease to decrease before or when it reaches the minimum death rate.

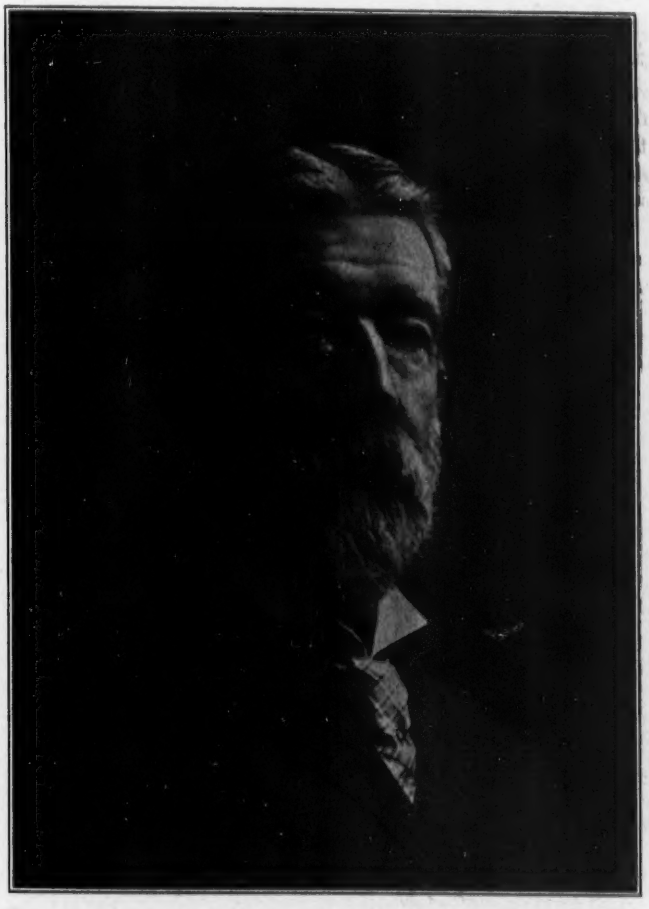
DR. LEWIS BOSS

THERE is no Nobel prize in astronomy, otherwise America would have had greater claims for the award than has been the case in medicine, physics and chemistry. It is a curious fact

that we have done better in sciences such as astronomy and zoology, having no immediate applications, than in medicine, physics and chemistry, where it might be supposed that the need of their applications and the wealth of the country would have led to researches in pure science. Perhaps the two greatest astronomers of the present generation have been Dr. G. W. Hill and the late Simon Newcomb. Another distinguished American astronomer, Lewis Boss, director of the Dudley Observatory at Albany, has died at the age of sixty-six years. His researches were technical in character, consisting largely of rigid determination of stellar positions. The catalogue in which he gives the positions and proper motions of 6,188 stars is a model of accurate work, and has led to discoveries of importance, such as the Taurus stream of stars. His work is highly appreciated by astronomers, and was given recognition by his appointment as director of the department of Meridian Astronomy of the Carnegie Institution. Science suffers severely in his death.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. John William Mallett, F.R.S., pro-



DR. LEWIS BOSS,
late director of the Dudley Observatory.

fessor emeritus of chemistry at the University of Virginia and eminent for his contributions to chemistry; of Dr. John Monroe Van Vleck, professor of mathematics at Wesleyan University from 1853 until his retirement as emeritus professor in 1904, and of Major General Robert Maitland O'Reilly, U.S.A., retired, former surgeon general of the United States Army.

DR. ANDREW D. WHITE, the first president of Cornell University, distinguished for his work in education and diplomacy, and for his publications on history and science, celebrated his eightieth birthday on November 7.—Dr. Edward W. Morley, the American chemist, has been made an honorary member of the Swiss Association for the Advancement of Science.—The gold medal for science of the Prussian government has been conferred on Dr. Robert Helmert, director of the Geodetic Institute of Potsdam.

THE American Association for the Advancement of Science and the national scientific societies affiliated with it will hold their convocation week meeting at Cleveland, Ohio, beginning on Monday, December 30. Cleveland is centrally situated between the Atlantic seaboard and the scientific centers of the central states, and Western Reserve University, the Case School of Applied Science, and the other scientific institutions of the city will supply excellent places of meeting. The address of the retiring president is made by Dr. C. E. Bessey, of the University of Nebraska, while Dr. E. C. Pickering, director of the Harvard College Observatory, will preside over the meeting. A large number of important and interesting addresses are assured from the vice-presidents of the association, the presidents of the affiliated societies and others who will take part in the scientific proceedings. There is sure to be a large attendance of scientific men. In recent years, however, the American Association has fallen behind the British Association in its influence on the general public and in the number of those not professionally engaged in scientific work who are attracted to its meetings. Those who are interested in such a meeting and might like to become members of the association should write to the permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

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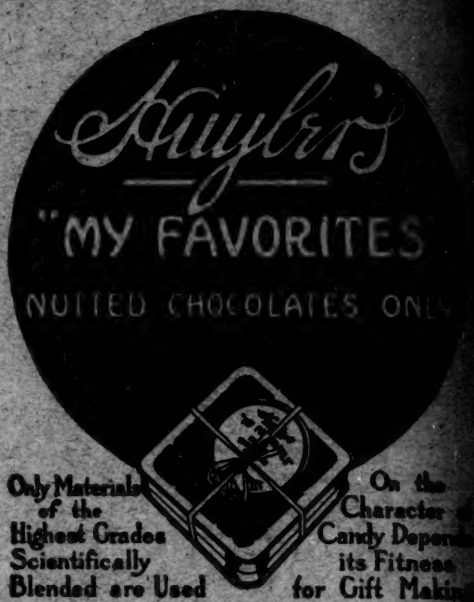

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